Advanced Microscopy Laboratory Expansion

Expression of Interest Request

Background:

UT-Battelle is requesting an Expression of Interest for construction of a new expansion to Building 3625- the Advanced Microscopy Laboratory (AML) located within the Oak Ridge National Laboratory in Oak Ridge, TN. This expansion is increasing the capability of the current advanced electron microscope capabilities at the AML. This project is funded as a U.S. Department of Energy, Office of Science general plant project. The AML Expansion award is anticipated to be ~$6M.

The design-build solicitation is scheduled for June 2022 with an award expected in late-summer 2022, with a final commissioning date of February 2024.

Scope:

The construction is detailed in the attached drawing package and summarized here in three phases of work:

1. Design
2. Construction
3. Commissioning and validation that construction is within microscope parameters

Submittal Request:

All interested firms are requested to provide the following items in a total of 3-pages or less including attachments:

1. Primary contact information including name, position, e-mail address and preferred telephone numbers for solicitation correspondence.

2. Narrative summary/overview that demonstrates your project understanding and approach to successful completion of the scope within the period of performance. A notional schedule may be provided as back-up.

3. Provide examples of two (2) facilities of similar size, scope, type, and function (Design-Build/DOE/Federal projects preferred). Lack of construction experience on federal installations will not automatically disqualify potential bidders. Projects constructed for private or public owners can also be provided.

4. Based on the information provided herein, proposed bidder shall propose non binding duration of:
   a. Number of weeks to develop and submit a proposal, after receiving RFP, which will include design proposed by the Offeror that meets and/or exceeds the intent of the performance specification.
   b. Complete 100%- CFC design package
   c. Construction (number of weeks including all public holidays) for this project from date of award.

Responses:
All responses should be in electronic format and sent no later than 12:00 PM EST on June 10, 2022 to UT-Battelle Senior Procurement Officer Chad Wilson (wilsoncr@ornl.gov)

Attachments

- Attachment 1 - Building 3625- Advanced Microscopy Laboratory (AML) Expansion Statement of Work.– For reference only
    - This SOW also includes performance specifications for the expansion and existing construction details.

Disclaimer: This EOI neither constitutes a solicitation, Request for Proposal (RFP), Invitation for Bid, or promise to issue an RFP in the future, nor does it restrict UT-Battelle to an ultimate acquisition approach. This EOI is issued solely for information and planning purposes and should not be construed as a commitment of any kind. EOI submission is not required to be considered for inclusion on the invitation to bid.

OAK RIDGE NATIONAL LABORATORY

OAK RIDGE, TENNESSEE A/E Design and Construction Support Services

Statement of Work

Building 3625- Advanced Microscopy Laboratory Expansion

Date: Mar 2022

Revision #: 0

☐ Issued by Procurement

Building 3625- Advanced Microscopy Laboratory (AML) Expansion

Statement of Work

Prepared by

UT-Battelle

for

OAK RIDGE NATIONAL LABORATORY

Oak Ridge, Tennessee 37831

3/9/2022

Steve Laman, Project Manager
Laboratory Modernization Division

Date

09Mar2022

Jimmy Landmesser, Jr., Principal Engineer
Laboratory Modernization Division

Date

Prepared for the U.S. Department of Energy
under U. S. Government Contract DE-AC05-00OR2272

Key Personnel & Contact Information

Role/Title	Name	E-mail	Office Phone	Cell Phone
Project Manager	Steven Laman	lamansl@ornl.gov	865-574-5766	865-382-3934
Principal Engineer	Jimmy Landmesser, Jr.	landmessjajr@ornl.gov	865-607-5331	865-607-5331

Note: These role assignments are subject to change. Updates will be provided if changes occur.

1.0 Purpose

The Oak Ridge National Laboratory (ORNL) will expand Building 3625. The purpose of the Advanced Microscopy Laboratory (AML) Expansion is to house a new microscope and all necessary building systems and microscope support space. The microscope will be procured and installed by ORNL.

The purpose of this statement of work (SOW) is to procure a fixed priced subcontract (FPSC) through a Design Build (DB) contractor to provide design and construction services for the AML Expansion. The detailed requirements for space to house the microscope and support equipment are provided in the Design Build Performance Specifications for the project.

2.0 Scope

The base scope is for Design-Build services to design and construct the AML Expansion for ORNL. This work is to be performed by as a turn-key Design-Build project. Project scope includes architectural programming, complete building design (inclusive of architectural and engineering systems required for building and equipment support), construction and turnover to ORNL operations. Target value design principles (design to cost) are to be utilized to develop a project that will not exceed a design and construction budget of $6,250,000.

The concept for the AML expansion is a single-story structure to be constructed as an addition to the south side of the existing AML. The existing facility is located on the main ORNL campus south of the intersection of Southside Avenue and Fifth Street. The expansion will provide a minimum of one (1) instrument room and equipment support space for a highly sensitive research microscope. The microscope will be provided and installed by ORNL. Please also provide an optional design for one (1) additional instrument room and equipment support space for a second highly sensitive research microscope.

3.0 Design

The design task is the development of a complete design package (construction documents including drawings and specifications), construction cost estimates at each design submittal. Design documents are to be submitted at the following stages of development: Design Development (60% design) and Certified for Construction (CFC) (100% design - signed and stamped for construction). The drawings and specifications shall be prepared in accordance with the AML Expansion - Design Build Performance Specifications (Attachment 1).

Refer to Section 6.0 for additional attachments the Company will provide.

Evaluation criteria have been established to help guide the Company in selecting the winning bid.

1) Design and schedule-
   a. Maximize building footprint within available buildable area.
   b. Ability to complete construction by May 2024.
   c. Provide highest quality facility infrastructure and equipment within budget.
2) Project-specific experience-
   a. Recent and relevant experience and project portfolio.
   b. Provided resumes for personnel
   c. Availability of said personnel for work on this specific project.

3.1 Schematic Design Documents

The Schematic Design is to be developed to establish a complete building and site development design to meet the program and budget. It shall be based on the AML Design Build Performance Specifications. A preliminary conceptual executive summary and associated sketches are provided as a guide and is not to be considered a complete or final design solution for the project. The Schematic Design documents (30%) shall be the first deliverable**.**

Schematic design package delivery date is to be June 10, 2022.

3.2 Design Development / Construction / CFC Documents

This continues the design process with the development of design development drawings and specifications (60%), construction drawings and technical specifications (100%), and final Certified for Construction (CFC) design drawings and technical specifications.

The Design Development/Construction Documents process will include an Company bi-weekly design and constructability review of design drawings, calculations, and technical construction specifications. The design review process is to utilize the Performance Specifications, Section 01 80 00, 3.2 as a guide. Modifications or deviations from these criteria are acceptable in coordination and approval by the ORNL Project Manager.

4.0 Construction

Construction of the expansion is to include all aspects required to safely construct the expansion to the AML. ORNL standard construction requirements are included in the AML Expansion Design Build Performance Specifications (Attachment 1) and are to be made part of the design technical specification. The construction period of performance is estimated to be December 2022 to May 2024. The A-E shall provide design and field support during the construction of the expansion.

An as-built drawing set is to be provided that includes incorporation of Seller red-lines, RFI solutions, and Company changes. The as-built documents are to be submitted in the same format as the design documents. The as-built record documents are to meet the requirements set forth in the 3625- AML Expansion Design Build Performance Specifications (Attachment 1), Section 01 78 39.

5.0 Deliverables and Schedule

The deliverables are to be provided to the ORNL TPO and Design Project Manager in accordance with the AML Expansion Design Build Performance Specifications (Attachment 1). Modifications to the design process outlined in the Performance Specifications are requested and are to be included in your proposal. Modifications will be considered that include a minimum of the industry standard requirements and should be addressed in the Schematic Design, Design Development, and Construction Document reviews. The process requested for conducting each design review is to be provided to the design project manager.

The following table identifies the A/E design milestone dates. Schedule and dates are pending funding and budget approvals.

Deliverable Number	Item	Completion Date/ Duration
3.1	Design:	
3.2.1	Design Development (60%) Review	Established by DB
3.2.2	Construction Documents (100%) Review	Established by DB
3.2.3	Certified for Construction (CFC) Design Review	September 2022
3.3	Construction	Complete by May 2024

6.0 List of Attachments

1. Bldg. 3625- AML Expansion Design-Build Performance Specification (07Mar2022)
2. ORNL- AML Original Building design documents and the previous 2009 expansion design documents
3. Geotechnical Exploration Report from construction of the existing facility.
4. ORNL- Advanced Microscopy Laboratory Expansion Conceptual Design Executive Summary, March 2022.
5. 220201-AML-South-SOW-MEPComments
6. FMS - Low EMI Design Guidance

End of Statement of Work

Advanced Microscopy Laboratory South Addition
Design Build Performance Specification

OAK RIDGE NATIONAL LABORATORY
OAK RIDGE, TENNESSEE

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SECTION 00 01 10 TABLE OF CONTENTS

END OF SECTION 00 01 10

MAIN ENTRY

- EMPLOYEES TYPICALLY ENTER AND EXIT HERE.
- AIR LOCK DOORS DO NOT FUNCTION PROPERLY.

CONTROL ROOMS

- CURRENTLYHOUSE ELECTRICAL EQUIPMENT FOR INSTRUMENTATION.
- MOST ALSO HOUSE CONTROL WORKSTATIONS.
- CONTROL WORKSTATIONS SHOULD BE LOCATED IN A SEPARATE ROOM TO AVOID INTERFERENCE.
- NEW CONTROL ROOMS SHOULD BE SMALLER.

INSTRUMENT ROOMS

- CURRENTLY HOUSE MICROSCOPES.
- CURRENT INTERIOR CLEARANCE IS LESS THAN 6" AT CEILING.
- NEW INSTRUMENT ROOMS NEED TO BE APPROX. 24" HIGHER INSIDE.
- CURRENTLY ISOLATED ON 18" SLABS.
- MOBILE CRANES USED PERIODICALLY FOR MANIPULATION OF EQUIPMENT.

PREP LAB STAGING AND

- BOTH ROOMS CURRENTLY USED FOR PREP.
- OFFICE ALSO HOUSES CONTROL WORKSTATION.
- MOBILE BAKING OVENS STORED IN CORRIDORS.
- THESE ROOMS APPEAR TO BE USED AS A BUFFER SPACE BETWEEN MECH. AND ELECTRICAL ROOMS AND THE RESEARCH AREAS.

SERVICE AND EQUIPMENT

- CYLINDERS AND TANKS ENTER/EXIT HERE APPROX. EVERY TWO WEEKS.
- AIR LOCK DOORS DO NOT FUNCTION AS NEEDED.

Figure 1. Plan Diagram of Existing AML

Figure 2. Campus Aerial for the new AML Expansion

1.3 SITE

The (AML) 3625 Building site is located on the south side of the 3000 Area as shown in (Figure 2) and also in the enlarged Campus Aerial view in the (Figure 3) Site Aerial showing AML Expansion.

1.3.1 Existing Site Conditions

The site grading directly around the building pad is moderately level on the northeast side but begins to increase on the southwest corner. The proposed 3,600 SF AML expansion to the south-east will move the building footprint location roughly three quarters out into the existing paved perimeter drive which will require the road to be closed off and have portions removed. The current building set back from the existing drive way curb is about 12’.

The indicated gray site area of the utility site plan layout in (Figure 6) is reflective of an approximately 4,500sf portion of the existing paved driveway that will be required to be removed and replaced with sidewalk and landscaped lawn. Because of sensitive lab research work, it was recommended remove that portion of roadway in order to limit the perimeter movement of traffic behind the AML Building. The proposed extents of driveway removal will need to be addressed in a civil drawing but are proposed to be up to the south-west gate on one side and over to the north-east drainage curb cut on the other.

The site landscaping shall be compatible with the existing landscaping and promote an open campus feel to the overall environment.

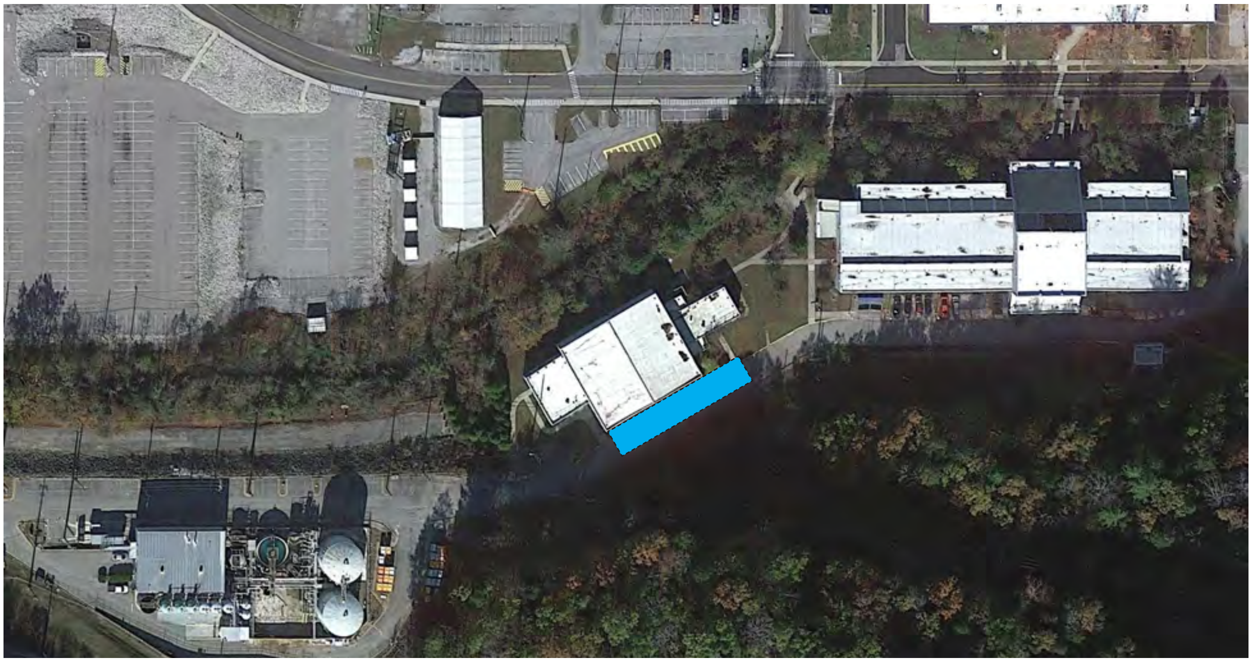

Figure 3. Campus Site for the new AML Expansion

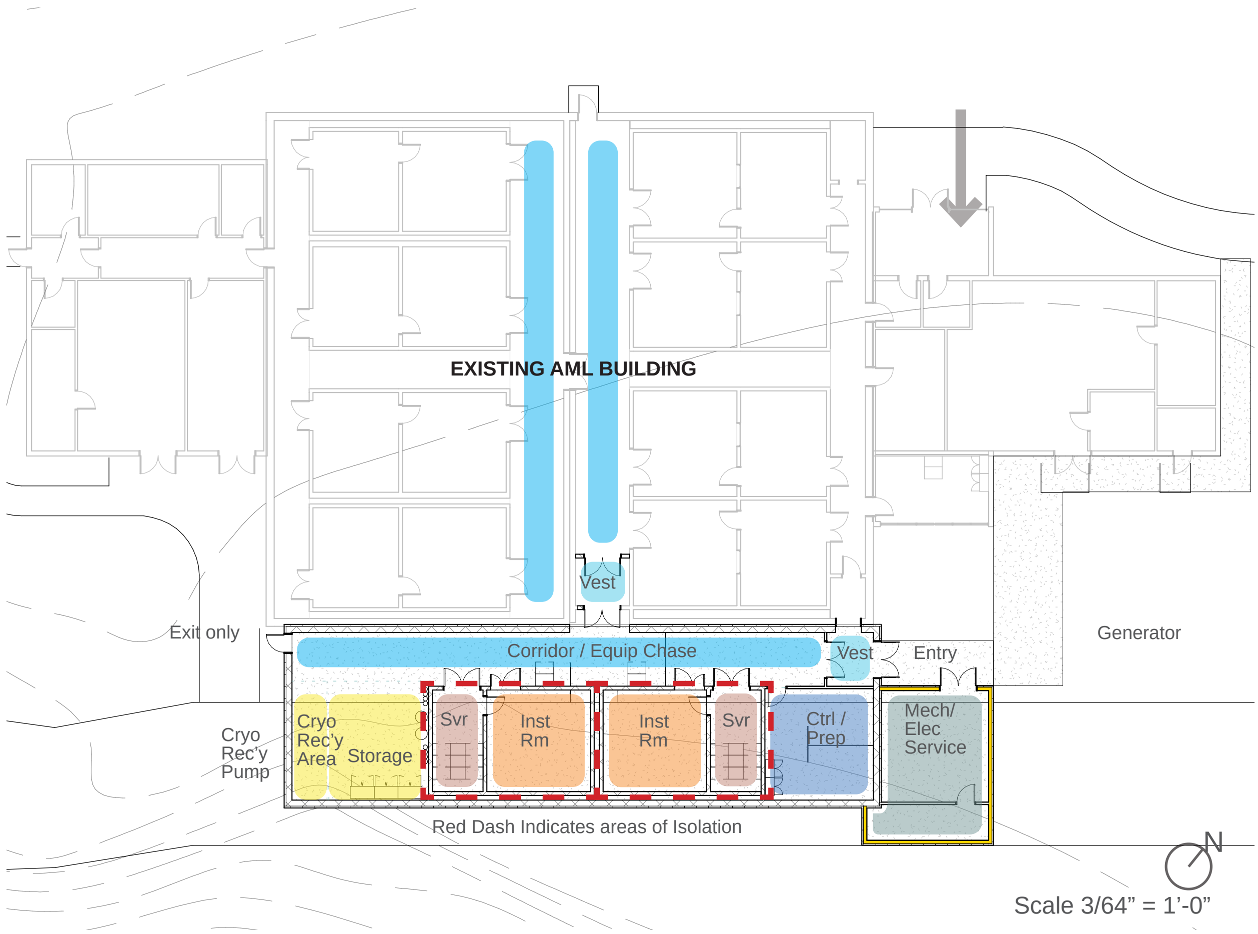

Figure 4. Bubble Diagram

1.4 BUILDING LAYOUT & MASSING

The configuration of the new AML expansion area is illustrated above in the (Figure 4) Bubble Diagram and in (Figure 5) Massing Diagram. The basic approach is to utilize the existing main front entry vestibule as the overall facility entrance and link to the new expansion area proposed via a continuation of the buffering Corridor / Equipment Chase areas as shown. The new expansion area will include a new smaller but separate entry to the northeast side to minimize the amount of disruption to the other areas of the facility as possible. All entry points will be controlled by Air Locks to control environmental pressure changes with 'exit only' points with no Air Lock. Because of utility access and service, the Mechanical / Electrical Equipment room is proposed to be located on the northeast side of the facility as well as the generator. The room arrangements shown proposes full separation to the Instrument / Server Rooms from the exterior wall and other adjoining spaces as well as separation joints at the slab. The Control Prep, Cryo Recovery Area and bordering Corridor / Equipment Chase will serve as vibration buffer zones to the Instrument / Server rooms.

Figure 5. 3D Concept Massing View from Southeast

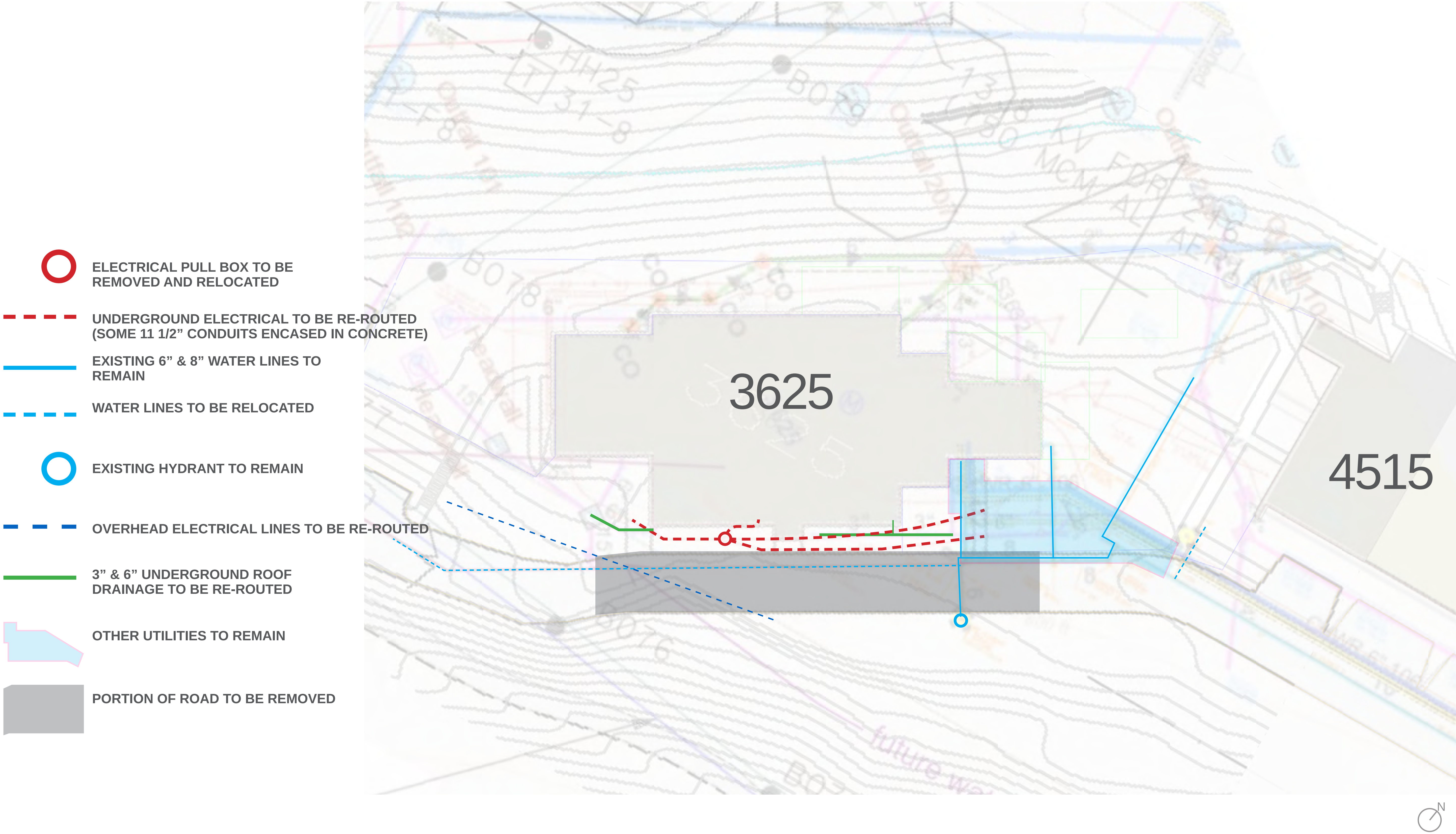

Figure 6. Existing Site Utilities Impacted by the AML Expansion

RELOCATED ELECTRICAL PULL-BOX

NEW ELECTRICAL CONDUITS

NEW WATER LINES

RE-ROUTED OVERHEAD ELECTRICAL

NEW AND RE-ROUTED ROOF DRAINAGE

PORTION OF ROAD TO BE REMOVED

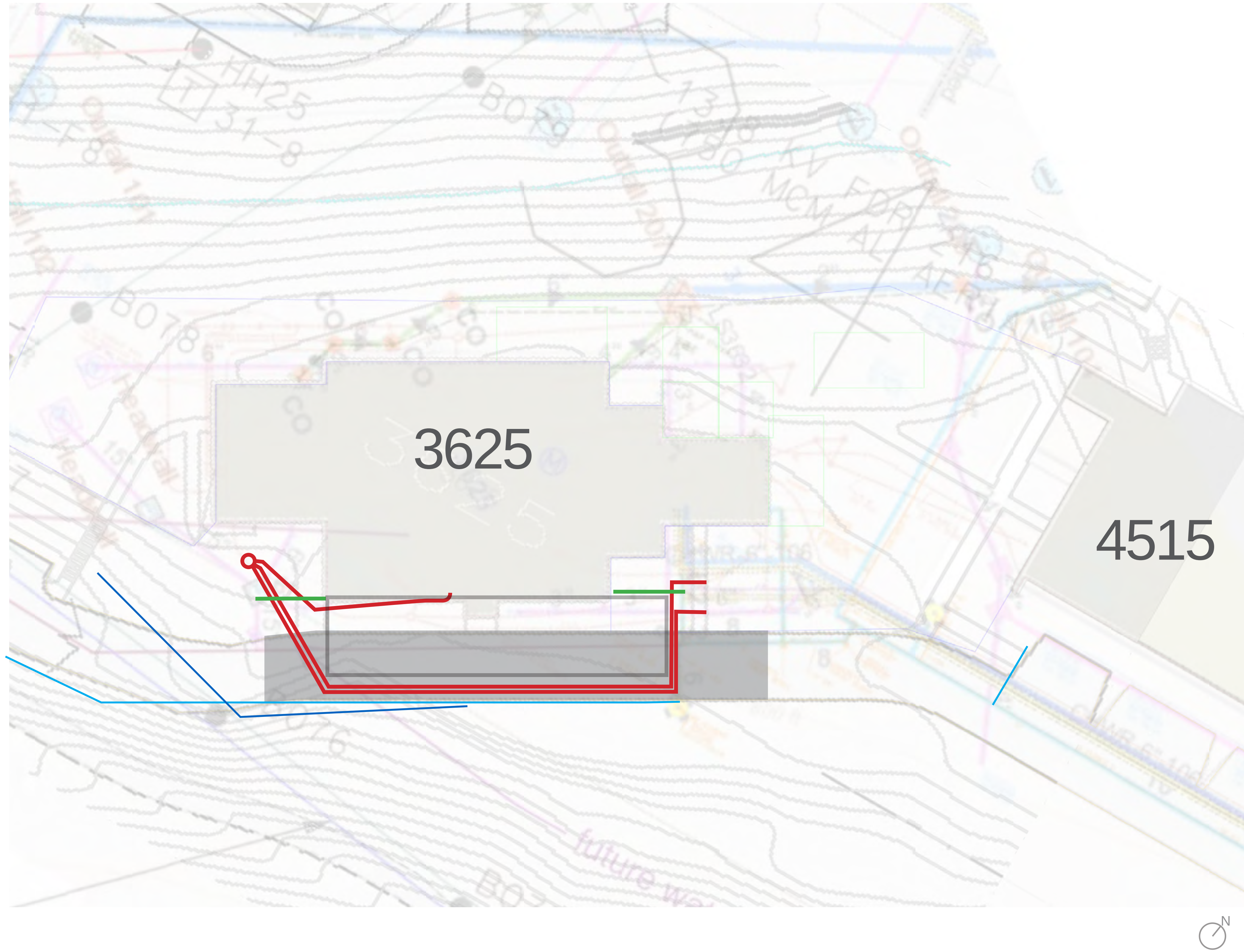

Figure 7. Proposed Utility Configuration for AML Expansion

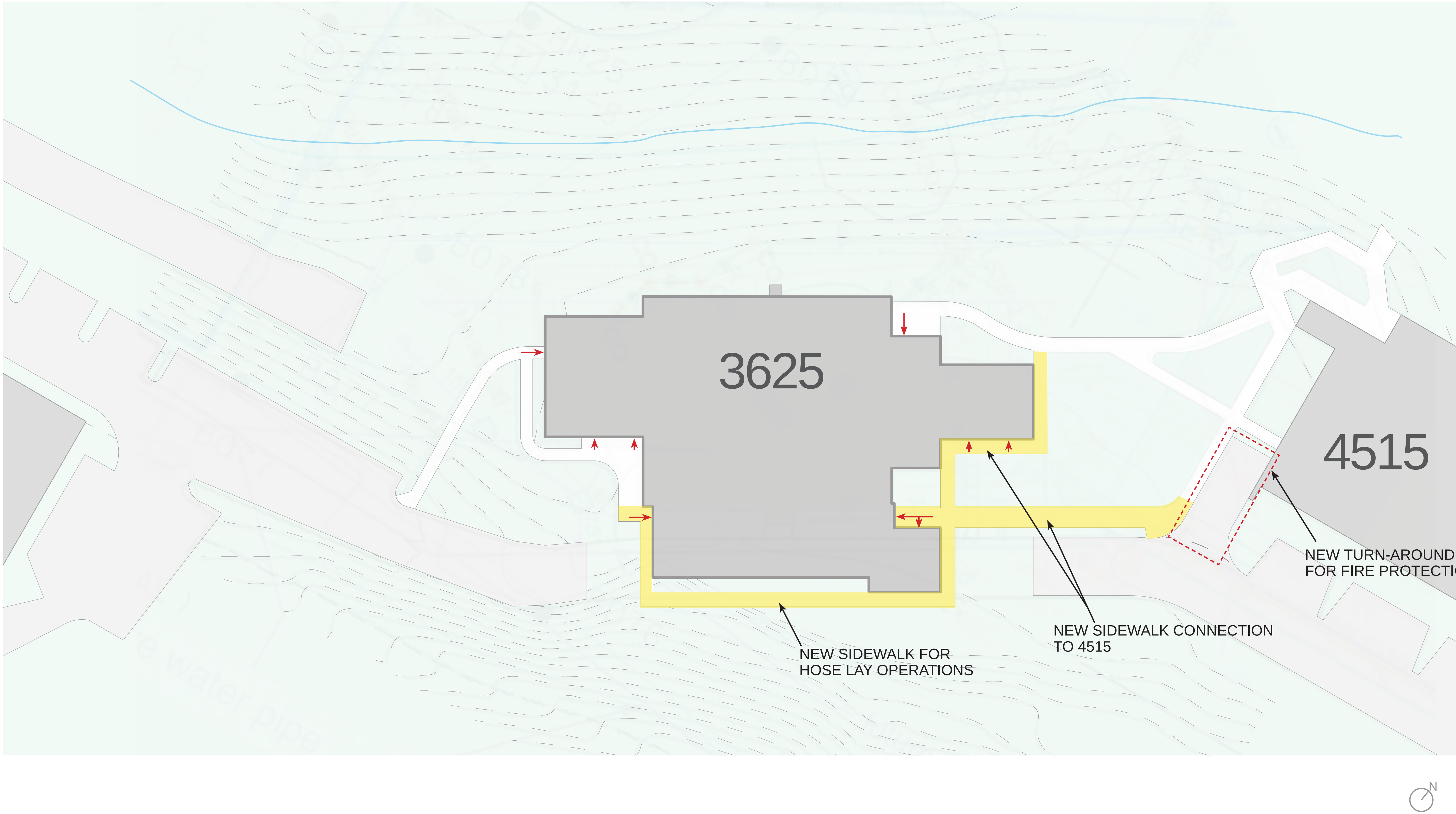

Figure 8. Proposed Paving and Sidewalks

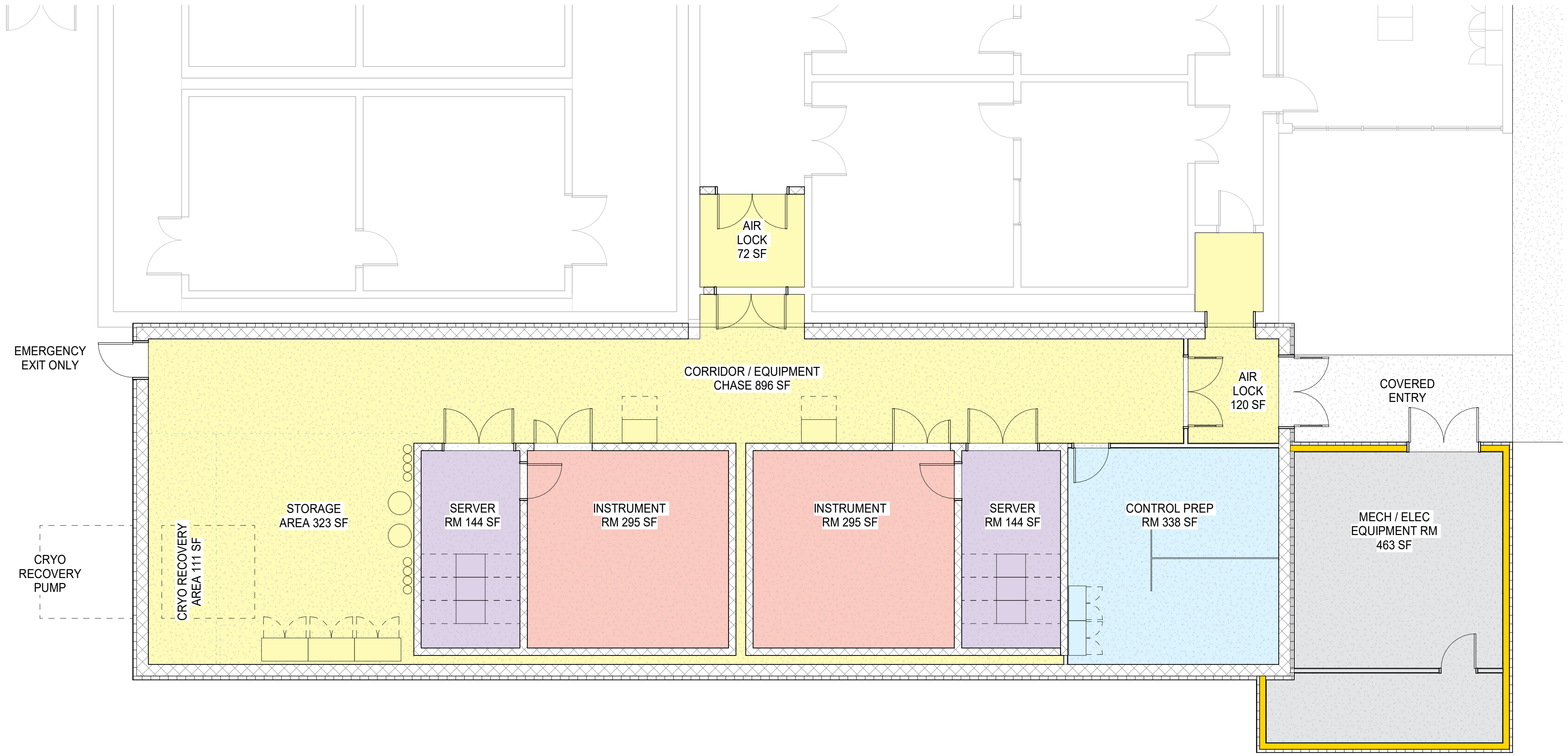

Figure 9. ORNL - Advanced Microscopy Laboratory Expansion - Floor Plan

Scale 1/8" = 1'-0"

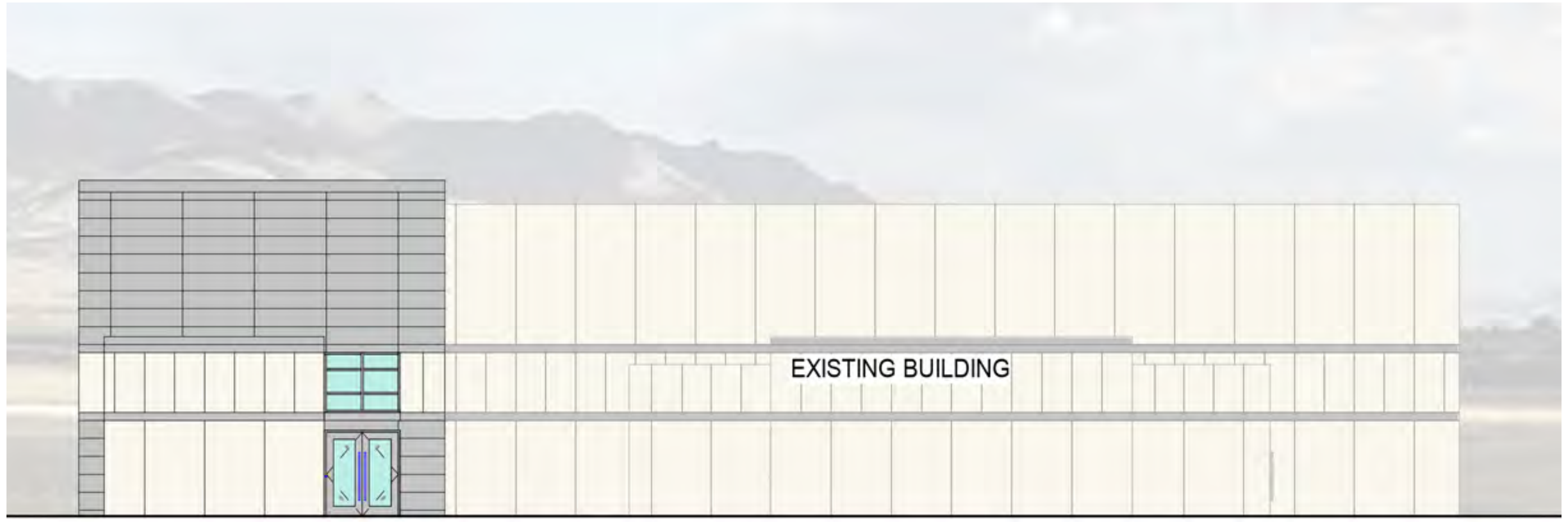

Figure 10. East Elevation

Figure 13. North Elevation

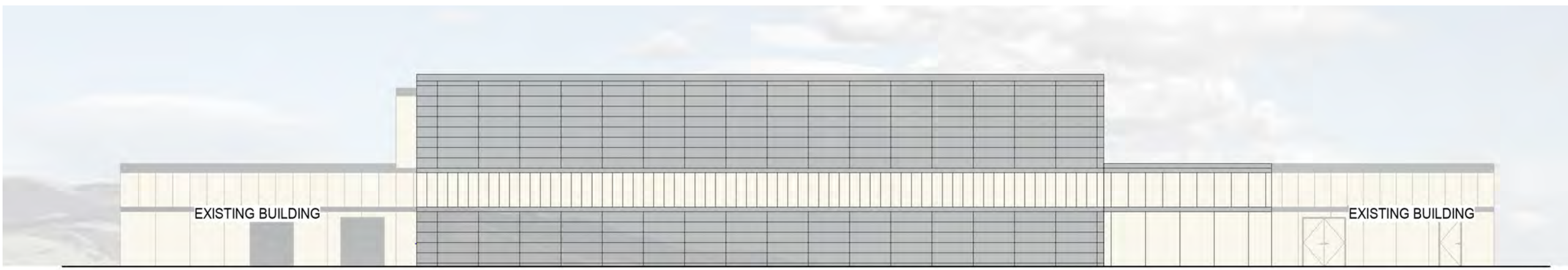

Figure 11. South Elevation

Figure 12. West Elevation

Figure 14. South-East Aerial View of AML

Figure 15. North-East Aerial View of AML

Figure 16. Ground Level View from 4515

Figure 17. Ground Level View from South-East Phase 3 Entrance of AML Expansion

Figure 18. Ground Level View from the South-East

SECTION 01 10 00 – SUMMARY OF WORK

PART 1 - PROJECT REQUIREMENTS

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 Specification Sections, inclusive of the Design/Build (D/B) specifications and related appendices or attachments, apply to this section. apply to this section.

1.2 PURPOSE

A. The information contained in this Design Build (D/B) Performance Specification establishes the minimum project requirements for spaces, functions, systems, characteristics, and materials and methods for the Seller to design and construct an addition to the Advanced Materials Laboratory (AML) building 3625 at Oak Ridge National Laboratory (ORNL).

B. As an experienced D/B team (Seller) that specializes in the design and construction of laboratory/research facilities, the Seller shall collaborate with the Company's Team throughout the design and construction process to successfully construct a high-performance laboratory/research facility, finishes, components, systems and features, as defined herein. The Seller shall evaluate the design concepts provided as an attachment and propose additional design improvements and increase the overall quality of the design using the talents, skills, and experience the D/B team (Seller) brings to the project.

C. The D/B Performance Specification requirements, expressed and implied, shall be used by the Seller to provide design services (schematic design and design development) and complete construction documents (construction drawings and specifications) required for approval, bidding and construction within budget limitations.

D. Conceptual drawings are provided for reference and represent a possible plan and site design configuration. The conceptual drawings are not to be considered the solution for the design. The Seller, with its laboratory and research design and construction expertise, shall use the technical requirements defined within this performance specification with the supporting information contained in the attachments to develop a complete design for Company approval. In the event of conflicting specification content, quantity, or code requirement, the Seller shall use the most stringent criteria, and/or the largest/greatest number specified.

1.3 DEFINITIONS

A. The Company: UT-Battelle LLC.
   1. The Company is the Code Authority and the Authority Having Jurisdiction.

B. Seller: Design/Build (D/B) offeror responsible for the design and construction of the project in accordance with these D/B Performance Specifications and the CFCs (contract documents).

C. Architect-Engineering (A-E): An Architectural firm currently licensed in the state of Tennessee and normally engaged in architectural work inclusive of the Architectural firm's Consulting Engineers currently licensed in the state of Tennessee and normally engaged in engineering design work, and any specialty Consultants, under contract with the Seller

D. Contract Documents, Certified for Construction (CFC): The contract documents (drawings and specifications) for the project issued, signed and professionally stamped by the A-E.

E. Atlas sheets: drawings showing utilities and subsurface interferences exterior to the ORNL buildings. The contents and accuracy of these drawings must be verified in the field.

1.4 SUMMARY

A. General.

1. The Advanced Microscopy Laboratory (AML) Addition will include the design for an approximately 3,600 gross square foot expansion to Building 3625 at ORNL. The addition to the existing facility will house a new microscope and related support systems as well as all building support systems (mechanical, electrical etc.). The design shall provide the optimal space that fully complies with all aspects of the installation and operational requirements of the microscope and the related support systems.
2. The high-performance characteristics of the microscope makes it ultra-sensitive to environmental influences such as fluctuating magnetic fields, micro-phonics, floor vibrations, electrical ground loops, airflow, and temperature variations. The primary purpose of the LIF will be to house these sensitive instruments in a way that will not compromise their design resolutions and functionality. The instrument room and instrument support spaces shall be designed to provide state of the art environmental stability to minimize the negative effects of all aspects of the physical environment identified in the Executive Summary and the microscope manufacturers' criteria for operations and installation.
3. The proposed location is on the south side of the existing facility. The addition shall be physically attached to the existing AML facility (building 3625). The AML is located on White Oak Avenue in the 3000 area of ORNL's East campus. The exact construction boundary will be defined in coordination with requirements of the completed design as approved by the Company.
4. The AML addition and related site improvements shall be designed and constructed to meet all aspects of this design build performance specification.
5. The Seller is to support one full day (or less if full day not necessary) of their entire design and preconstruction team at the design development (60%) review meeting at ORNL to review comments from the Company.

B. Architectural design and construction.

1. The programmatic space requirements will be developed as a part of the design process. Space requirements shall be based on microscope and related support and infrastructure requirements defined by the manufacturer of the microscope. Minimum general design requirements shall be but are not limited to the following:
   a. The configuration and layout of the addition shall not compromise the interior and exterior functionality of the existing facility.
   b. The configuration of space shall be designed in a manner that provides convenient access between the addition and staff/public circulation areas of the existing facility
   c. The design shall optimize the available site to provide the maximum amount of research space and minimize ancillary and support space within the project budget.

C. Site design and construction.

1. Site surveys from the previous 2009 expansion as well as one completed February 2022 to provide complete topographic information for the construction limits and adjacent surroundings to support any design and construction requirements is provided in Attachment 2 to the Design Build Statement of Work.
2. A geotechnical report from the original facility construction to support design and construction requirements is provided in Attachment 3 to the Design Build Statement of Work. Should additional geotechnical investigation be required for the design, they shall be the responsibility of the Seller
3. Site work includes all aspects for removing, relocating or replacing, and installing new utilities, driveways, parking and travel routes, landscaping areas, and requirements for building and site development construction.
4. Existing utilities to remain shall be protected at all times from construction traffic and utility protection shall be provided in the Facility Design.
5. Design and installation of site storm water piping and installation of storm water retention is not required to comply with EPA and EISA requirements since the expansion is less than 5,000 $ft.^2$.
6. Replacement of existing storm, sanitary sewer and potable water utilities as required shall be compliant for design needs and replacement of outdated and deteriorated piping and appurtenances that may exist on site or new construction is required to tie into or interface with existing systems.
7. Removal and replacement of subgrade utilities and installation of new utilities serving the facility as required. This includes but is not limited to potable water, fire water, storm sewer, sanitary sewer, natural gas, electrical and communications (including fiber optic).
8. Improvements and accommodation of existing access drive to nearby and adjacent facilities.
9. The Company expects to have an early site package (100%) delivered at the 60% facility design submittal.

PART 2 - CODES AND STANDARDS

2.1 DESIGN STANDARDS

A. Work Smart Standards (WSS).
   1. Design and construction of the facility shall be in accordance with the WSS as applicable including deviations and other standards as listed in Section 01 41 00.

B. Additional standards/guides.
   1. As noted in the sections that follow.
   2. Standard Method for Measuring Floor Area in Office Buildings, American National Standards Institute (ANSI)/Building Owners and Managers Association (BOMA) Z65.1.
      a. Net usable square footage.
         1) Programmed square footage that meets the user requirements as specified in the room data sheets. Net usable square footage does not include walls enclosing program spaces.
      b. Gross square footage.
         1) The area encompassed by the exterior dimensions of the facility at each floor level, not to include any open roof area. Upper levels of two-story spaces and exterior decks are to be included at ½ the actual square footage.

C. The Company: UT-Battelle LLC.
   1. The Company is the Code Authority and the Authority Having Jurisdiction.

D. Seller: Design/Build (DB) contractor responsible for the design and construction of the project in accordance with these Performance Specifications and the CFC's (contract documents).

E. Architect-Engineering (A-E): An Architectural firm currently licensed in the state of Tennessee and normally engage in architectural work and the Architectural firm's Consulting Engineers currently licensed in the state of Tennessee and normally engage in engineering design work, and any specialty Consultants, under contract with the Seller

F. Contract Documents, Certified for Construction (CFC): The contract documents (drawings and specifications) for the project issued, signed and professionally stamped by the A-E.

G. Atlas sheets: drawings showing utilities exterior to the ORNL buildings. The contents and accuracy of these drawings must be verified in the field.

H. WSS:
   1. Codes/Standards required as part of the UT-B contract with DOE.
   2. See Section 01 41 00.

I. Additional standards/guides.
   1. See Section 01 41 00 and Attachment 5- Design Codes and Standards.

2. Revision dates for the standards/guides are the revision dates in effect on the issue date of the project specific design criteria.

PART 3 - TECHNICAL REQUIREMENTS

3.1 PROJECT EXECUTION

A. GENERAL.
   1. The execution of the project will be as follows:
      a. Fixed price, Design-Build contract shall be utilized for the design and construction of the project.

B. The Company.
   1. The Company will provide project, design and construction oversight.

C. The Seller.
   1. The Seller shall provide an A-E to design the project and produce the CFC’s (contract documents), as established in this design build performance specification.
   2. The Seller shall construct the project per the approved CFC’s contract documents.

D. The A-E.
   1. The A-E shall provide the CFC package, as established in this design build performance specification.
      a. The conceptual design plans and related drawings included in AML Preliminary Design and Executive Summary define a concept that integrates the facility with the ORNL campus. The overriding factors for the configuration are in meeting the unique requirements outlined in this performance specification and the microscope manufacturers performance criteria and installation requirements. The A-E shall utilize the information in this design build performance specification and the manufacturers performance and installation requirements to establish the design and configuration of the addition to the AML.

END OF SECTION 01 10 00

SECTION 01 18 00 – PROJECT UTILITY INTERFACE

PART 1 - PROJECT REQUIREMENTS

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for utility construction interface with the Utility Division of Company.

B. Inspections provided by the Company do not relieve Seller of responsibility for compliance with the Contract Document requirements.

C. If conflicts exist between this section and other sections, this section takes precedence.

1.3 REFERENCES

A. Section 01 01 00 – General Work Requirements

B. Section 01 55 00 – Environmental Protection

C. Section 01 78 39 – Project Record Documents

D. ANSI/AWWA C651 – Disinfecting Water Mains

E. Division of Water Resources, TDEC, Community Public Water Systems Design Criteria

1.4 SUBMITTALS

A. Evaluation Reports: The Seller shall include notification time and hold points in their schedule submitted per Section 01 01 00 General Work Requirements.

B. Disinfection Plan: Provide detailed plan for Company approval a minimum of fourteen days prior to implementation.

C. As-Built Utility Drawings: Provide as-built utility drawings in MicroStation or AutoCAD format within 45 days of closing the excavation per Section 01 78 39 Project Record Documents.

PART 2 - TECHNICAL REQUIREMENTS

2.1 COMPANY EVALUATIONS

A. Testing
   1. The Utility Division of Company requires 48-hour notice before witnessing the following tests:
      a. Hydrostatic/Pneumatic testing of all underground utilities including but not limited to: potable water; natural gas; Compressed air, chilled and tower water systems, steam and steam condensate.
      b. Other critical testing activities as defined in the specifications.

B. Potable Water Disinfection
   1. The Utility Division of Company will provide testing for free chlorine level of the heavily chlorinated water disinfection prior to the required 24 hour hold period and post hold period.
   2. After the heavily chlorinated water has been flushed from the system the Utility Division of Company will verify the free residual chlorine level is between 1-4 ppm.
   3. After the 48 hours hold period, the Utility Division of Company will collect a bacteriological sample.
   4. The State Laboratory does not accept samples Friday through Sunday or on Holidays.
   5. The Utility Division of Company will provide results of the bacteriological sample generally within 24 hours.

C. Cleaning and Flushing
   1. Perform per ORNL Specification 33 61 24 Cleaning and Flushing of Chilled Water, Heating Water, And Cooling Tower Water Systems.

D. Buried Service Field Inspection
   1. All buried services shall be evaluated by the Company prior to backfilling
   2. Notify Company at least 48 hours advance notice of buried services construction completion for Company evaluation.
   3. Company evaluation(s) will be performed by Utilities Division and Laboratory Modernization Division personnel and may be scheduled for more than one event.
   4. Inspection includes but is not limited to:
      a. 100% inspection for code and specification compliance by the Reviewer and/or responsible EAHJ prior to covering or backfill by the contractor.
      b. Confirmation that the design intent is being met by the contractor.
      c. Confirmation of compliance with the specifications.
      d. Witness critical testing and inspection activities as defined in the specifications.

2.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

B. Protect construction exposed for field examination activities.

C. Repair and protection are Seller's responsibility, regardless of the assignment of responsibility for quality-control services.

PART 3 - EXECUTION

A. Materials
   1. Buried piping.
      a. Indicator tape shall be laid 18” above buried piping.
      b. Tracer wire shall be laid continuously along to top of all buried piping.
      c. Attach the wire at five-foot intervals to the pipeline with several wraps of tape.
      d. Tracer wire shall run up and down exterior side of valve boxes, looped but not cut, into the valve box just below the cover.
      e. Splices shall be avoided. Splices and wire ends shall be waterproofed.
      f. Verify electrical continuity by applying an electrical current.
      g. Wire Spec: 14 AWG conductor, solid white, TWH solid copper with plastic coat. Splice connectors: Burndy KS-90 16-10 wrapped with insulating mastic tape.
      h. The ends of the tracer wire shall terminate inside a valve or junction box. A minimum of twelve inches of wire shall be located within the box.
   2. All materials/equipment shall bear the Underwriter’s Laboratories (UL) label or be approved by Factory Mutual (FM) where UL labels or FM approval is available for the type of products specified.

END OF SECTION 01 18 00

SECTION 01 22 00 - UNIT PRICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for unit prices.

B. Related Requirements:
   1. Section 01 40 00 "Quality Requirements" for field testing by an independent testing agency.

1.3 DEFINITIONS

A. Unit price is stated on the Bid Form, as a price per unit of measurement for materials or services, added to or deducted from the Contract Sum by appropriate modification, if the estimated quantities of Work required by the Contract Documents are increased or decreased.

1.4 PROCEDURES

A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.

B. Measurement and Payment: See individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.

C. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.

D. List of Unit Prices: A list of unit prices is included in Part 3. Specification Sections referenced in the Part 3 "Schedule of Unit Prices" Article contain requirements for materials described under each unit price.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF UNIT PRICES

A. Unit Price No. 1: Removal of unsatisfactory soil and replacement with satisfactory soil material.

1. Description: Unsatisfactory soil excavation and disposal off-site and replacement with satisfactory fill material or engineered fill from off-site, as required, in accordance with Section 312000 "Earth Moving."
2. Unit of Measurement: cubic yard of soil excavated, based on in-place surveys of volume before and after removal.

B. Unit Price No. 2: Mass rock excavation and replacement with satisfactory soil material.

1. Description: Classified mass rock excavation and disposal off-site and replacement with satisfactory fill material or engineered fill from off-site, as required, in accordance with Section 312000 "Earth Moving."
2. Unit of Measurement: cubic yard of rock excavated, based on in-place surveys of volume before and after removal.

C. Unit Price No. 3: Trench rock excavation and replacement with satisfactory soil material.

1. Description: Classified trench rock excavation and disposal off-site and replacement with satisfactory fill material or engineered fill from off-site, as required, in accordance with Section 312000 "Earth Moving."
2. Unit of Measurement: cubic yard of rock excavated, based on survey of in-place surveys volume of before and after removal.

END OF SECTION 01 22 00

SECTION 01 23 00 - ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. Section 01 81 00 - Facility Performance Requirements for details on alternates.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS

A. Alternate: An amount proposed by Seller and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if the Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternates into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.

1. Include, as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation, whether or not indicated as part of alternate.

B. Execute accepted alternates under the same conditions as other Work of the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. Provide expansion option for the building and site design to accommodate one additional microscope and necessary support and infrastructure to serve additional microscope. The alternate shall be designed in a manner so that the alternate can be constructed as a part of initial construction or at a future date as a separate project.

END OF SECTION 012300

SECTION 01 32 00 - PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for progress documentation.

1.3 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.

1. Critical activities are activities on the critical path. They must start and finish on the planned early start and finish times to avoid delay in the overall schedule.
2. Predecessor Activity: An activity that precedes another activity in the network.
3. Successor Activity: An activity that follows another activity in the network.

B. Baseline: The D/B contractor submitted, ORNL approved, design and construction schedule that is maintained throughout the life of the contract. The schedule baseline serves as a base or standard against which project performance can be measured, monitored, and reported during the performance of the project. Once established, the baseline is subject to the change control process. Prior to execution against the plan, a copy of the schedule baseline is created (current schedule) which is utilized to record the status as the work is assesses over time leaving the baseline as it was originally established (or latest revision from the approved changes) for comparison to the current performance.

C. Cost Loading: The allocation of the schedule of values for completing an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum.

D. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

E. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

F. Earned Value: The amount of progress, or amount earned for an activity with budgeted cost. Earned value is equal to the % complete times the budget.

G. Event: The starting or ending point of an activity.

H. Float: The measure of leeway in starting and completing an activity.

I. Major Work Elements: Significant construction elements which identify each major portion of the work scope. These elements should be consistent with the Schedule of Values as established for payment.

J. Milestone: A key or critical point in time for reference or measurement.

K. Percent (%) Complete: The measure of physical progress on an activity or task.

1.4 SUBMITTALS

A. Design Schedule: Submit for approval fourteen (14) calendar days after Award of Notice a schedule covering the development, submission, and ORNL review and approval of the Design Packages as identified in the Performance Specification. The Design Schedule shall begin with DB Contractor receipt of Notice of Award and progress through ORNL review and approval of all issued for construction design packages.

B. Construction Schedule: Submit for approval concurrent with submission of initial design package for construction a detailed schedule covering all construction related activities covering the entire remaining Contract Period of Performance.

C. Reports:
   1. Updated CPM Schedule: (at monthly intervals to correspond with payment application)
   2. Daily Construction Reports
   3. Manpower Reports: (at monthly intervals to correspond with payment application)
   4. Meeting Minutes: documenting discussions during design and construction progress meetings.

PART 2 - PRODUCTS

2.1 SCHEDULE SOFTWARE

A. Prepare schedule(s) using commercial planning software. The preferred software is Oracle's Primavera P6 Professional software. Other planning software may be used if approved by ORNL and compatible with Primavera P6 Professional software.

PART 3 - EXECUTION

3.1 SCHEDULE PREPARATION

A. Schedule format shall be detailed, integrated, cost loaded, Critical Path Method time-scaled logic diagram. At a minimum, activity bars, activity descriptions and numbers, constraints, milestones, cost loading value and critical path shall be shown.

B. Activity durations shall be in working days. Typically, activity durations shall not exceed 20 days, with exception of level-of-effort activities. Activity titles shall be clearly stated. Identify original duration, remaining duration, % complete, early start, early finish, critical path and cost loaded value.

C. Submittal Review Time: Include allowance for review and re-submittal time of Contract required data.

D. Activity description logic sequence and relationship. Schedules shall identify critical path activities, including logical sequence and relationship of activities for engineering, design, submittals, procurement, fabrication, delivery, erection, construction, installation, and testing of work covered by Contract.

E. Major Work Elements: Identify each major portion of work required for construction. This information should align with the established Schedule of Values.

F. Work Stages: Indicate important stages of construction within each major work element, including, but not limited to:
1. Design
2. Subcontract Awards
3. Mobilization
4. Submittals
5. Purchases
6. Mockups
7. Fabrication
8. Sample Testing
9. Deliveries
10. Installation
11. Tests and Inspections
12. Commissioning

G. Milestones should be included for major events such as:
1. Notice of Award
2. Notice to Proceed
3. Foundation and Floor Slabs Complete
4. Structural Steel Erection Complete
5. Building Weather-Tight
6. Completion of Mechanical Installations
7. Completion of Electrical Installations
8. Interiors Complete

9. Commissioning Complete
10. Substantial Completion
11. Final Completion

3.3 SCHEDULE MAINTENANCE

A. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis demonstrating the effect of the proposed change on the overall project schedule.

B. Schedule Updating: At monthly intervals, a review of job progress shall take place between the D/B Contractor and designated ORNL representatives to determine actual progress. Participants shall compare actual job progress with scheduled progress. The parties shall determine percent complete for each applicable activity. The D/B Contractor's monthly application for payment shall be consistent with the information presented in the updated schedule. The schedule shall be revised immediately after each such meeting to incorporate any necessary revisions.

3.4 REPORTS

A. Monthly CPM Schedule Update: The D/B Contractor shall prepare and submit with its monthly billing an updated CPM schedule that reflects the physical progress and current start and finish dates of each scheduled activity. The schedule shall compare the progress to date to the approved baseline, including the effect of any delays and changes.
   1. The schedule shall include the following information:
      a. Activity ID
      b. Activity Description
      c. Early Start
      d. Early Finish
      e. Baseline Start
      f. Baseline Finish
      g. % Complete
      h. Budgeted Cost
      i. Earned Value
   2. Critical path activities should be highlighted
   3. ORNL shall require that the schedule be provided electronically in a format compatible with the schedule software identified
   4. The D/B Contractor shall issue the update in alignment with ORNL's financial processing calendar. The D/B Contractor's monthly Application for Payment shall be consistent with the information presented in the updated schedule.

B. Daily Construction Reports: Prepare a daily construction report recording information concerning events at Project site. Daily report should be on the Daily Activities and Manpower Report (see attached) or equivalent as approved by the Company. Submit a copy of the report to Construction Field Representative (CFR) and Project Manager (PM) by noon of the following workday. Daily construction report should include the following information:

1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.
4. Equipment at Project site.
5. Material deliveries.
6. High and low temperatures and general weather conditions, including presence of rain or snow.
7. Testing and inspection.
8. Accidents.
9. Meetings and significant decisions.
10. Unusual events.
11. Stoppages, delays, shortages, and losses.
12. Meter readings and similar recordings.
13. Emergency procedures.
14. Orders and requests of authorities having jurisdiction.
15. Change Orders received and implemented.
16. Construction Change Directives received and implemented.
17. Services connected and disconnected.
18. Equipment or system tests and startups.
19. Partial completions and occupancies.
20. Substantial Completions authorized.

C. Manpower Report. The D/B Contractor shall report all hours worked on-site on a monthly basis. The report shall itemize labor hours by D/B Contractor direct report employee and subcontractor employee.

D. Four Week Look Ahead. The D/B Contractor shall prepare and submit n a weekly basis a four-week schedule that looks at the upcoming four weeks in the construction schedule on a detailed level that forecasts daily planning of the work, and outages and interfaces with existing utilities, systems, services, and building personnel.

E. Progress Meetings: The D/B Contractor and ORNL shall hold progress meeting during design and construction activities. The frequency of the design progress meetings shall be at the discretion of the D/B Contractor and shall be held on ORNL Campus. During construction, the D/B Contractor, Designer of Record (DOR), major sub-tier contractors and Battelle shall meet weekly on the construction site at the D/B Contractor site office to discuss progress. The D/B Contractor shall document the discussions held during the progress meetings and shall prepare and provide ORNL with minutes of the meetings.

3.5 CONSTRUCTION PHOTOGRAPHS

A. Date Stamp: Unless otherwise indicated, date and time stamp each photograph as it is being taken so stamp is integral to photograph.

B. Pre-construction Photographs: Before starting construction, take photographs of project site and surrounding properties from different vantage points. Show existing conditions adjacent to property.

C. Periodic Construction Photographs: Take photographs monthly, coinciding with cutoff date associated with each Application for Payment. Photographer shall select vantage points to best show status of construction and progress since last photographs were taken.

D. Final Completion Construction Photographs: Take photographs after date of Substantial Completion for submission as Project Record Documents.

END OF SECTION 01 32 00

Daily Activities and Manpower Report

Due to CFR no later than noon of the following day (e.g., Monday's report due no later than noon Tuesday).

Subcontract Name: ______________________________

Subcontract Number: ______________________________

Subcontractor: ______________________________

Date: ____________________ Weather Conditions: ____________________

Day: ____________________ Temperature: ____________________

Day #: Precipitation:

* Class A: No interruptions of any kind from weather conditions occurring on this or previous shifts.
Class B: Weather occurred during this shift that caused a complete stoppage of all work.
Class C: Weather occurred during this shift that caused a partial stoppage of work.
Class D: Weather overhead excellent/suitable during shift; work completely stopped due to results of previous adverse weather.
Class E: Weather overhead excellent/suitable during shift. Work partially stopped due to previous adverse weather.

# Of Employees	Classification	Company	Hours

Date	Subcontract Number:

Activity	Describe in detail work performed

Equipment	Description	Materials Placed/Delivered

Work delayed or impacted?	No	Yes, provide details:
Extra work required?	No	Yes, provide details:
QA/Test/Inspections?	No	Yes, provide details:
Safety comments?	No	Yes, provide details:
Visitors?	No	Yes, provide details:
Instructions given/received?	No	Yes, provide details (source, describe):
Job site photographs taken today?	No	Yes
Jobsite safety meeting held today? Topic:	No	Yes

Accident incurred today?	No	Yes Details:
Accident report prepared? Details:	No	Yes

SECTION 01 33 00 –SUBMITTAL PROCEDURES

PART 1 - PROJECT REQUIREMENTS

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.

1.2 SUMMARY

A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting shop drawings, product data, samples, design documents and other submittals.

1.3 REFERENCE SECTIONS

A. Section 01 80 00 Design Build Requirements for design submittals.

1.4 DEFINITIONS

A. Delegated-Design Services: Professional design services, Architect-Engineer (A-E), or certifications by a design professional specifically required of the Seller by the Contract Documents.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Processing time for Company review"
   1. Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on the Company's receipt of submittal. No extension of the contract time will be authorized because of failure to transmit submittals enough in advance of the work to permit processing, including resubmittals.
   2. Initial review: allow 10 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. The Company will advise the Seller when a submittal being processed must be delayed for coordination.
   3. Intermediate review: if intermediate submittal is necessary, process it in same manner as initial submittal.
   4. Resubmittal review: allow 10 days for review of each resubmittal.

B. Processing Time for State of Tennessee Review:
   1. Allow 10 days for review by Company of each submittal before the Company transmits to the State of Tennessee. Allow additional time if coordination with subsequent submittals is required.

2. State of Tennessee Review: Generally, 30 days. Seller shall verify timeframe required by the State of Tennessee.
3. Submittals shall be in the format as required by the State of Tennessee.

C. Identification and Information:
1. Provide the submittal information as stated in the subcontract documents.

PART 2 - NOT USED

PART 3 - TECHNICAL REQUIREMENTS

3.1 SUBMITTAL PROCEDURES

A. General
1. Coordinate submittal information through the Company's TPO and Procurement representative.
2. Provide the submittal information as stated in the subcontract documents.
3. Identify submittal information with contract number, project title, the Seller's name, and date submitted.
4. Submittals shall be in electronic format with digital bookmarks, where possible, and will be managed using the Seller’s electronic submittal program approved by the Company.
5. Items submitted or resubmitted for review will be returned within [**five**] business days with one of the following comments:
   a. Approved no comments.
   b. Approved with comments, revise and resubmit.
   c. Approved with comments, resubmittal not required.
   d. Rejected, revised and resubmit
   e. Review not required.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. Mark each copy of each submittal to show which products and options are applicable.
   a. Options: Identify options requiring selection by the Company.
   b. Deviations: Identify deviations from the Contract Documents on submittals.
2. Include the following information, as applicable:
   a. Manufacturer's catalog cutsheets including dimensional drawings as applicable.
   b. Manufacturer's product specifications.
   c. Standard color charts.
   d. Statement of compliance with specified referenced standards.
   e. Testing by recognized testing agency.
   f. Application of testing agency labels and seals.
   g. Notation of coordination requirements.
   h. Availability and delivery time information.
3. For equipment, include the following in addition to the above, as applicable:
   a. Wiring diagrams showing factory-installed wiring.
   b. Printed performance curves.

c. Operational range diagrams.
d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
a. Identification of products.
b. Schedules.
c. Compliance with specified standards.
d. Notation of coordination requirements.
e. Notation of dimensions established by field measurement.
f. Relationship and attachment to adjoining construction clearly indicated.
g. Seal and signature of professional engineer if specified.
2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 42 inches.

D. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on American Welding Society (AWS) forms. Include names of firms and personnel certified.

E. Field Test Reports: Submit reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.

F. Maintenance Data: Comply with requirements specified in Section 01 78 23, Facility Systems Manual.

3.2 DELEGATED-DESIGN, A-E, SERVICES

A. See Section 01 80 00 Design Build Requirements for design submittals.

3.3 SELLER'S REVIEW

A. Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents before submitting to Company. Note corrections and field dimensions.

B. Project Closeout and Maintenance/Material Submittals: Refer to requirements in Section 01 77 00, Closeout Procedures.

END OF SECTION 01 33 00

SECTION 01 40 00 – QUALITY REQUIREMENTS

PART 1 - PROJECT REQUIREMENTS

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve the Seller of responsibility for compliance with the contract document requirements.

C. Related sections:
   1. Division Sections 02 through 49 for specific test and inspection requirements.

1.3 DEFINITIONS

A. Field quality-control testing: tests and inspections that are performed on-site for installation of the work and for completed work.

B. Installer/Applicator/Erector: the Seller or another entity engaged by the Seller as an employee, subcontractor, or sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

1.4 CONFLICTING REQUIREMENTS

A. Referenced standards: if compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to the Company for a decision before proceeding.

1.5 SUBMITTALS

A. Shop drawings: provide plans, sections, and elevations, indicating materials.
   1. Indicate manufacturer and model number of individual components.
   2. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

B. Qualification Data: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

1.6 REPORTS AND DOCUMENTS

A. Test and inspection reports: prepare and submit certified written reports specified in other sections. Include the following:
   1. Date of issue.
   2. Project title and number.
   3. Name, address, and telephone number of testing agency.
   4. Dates and locations of samples and tests or inspections.
   5. Names of individuals making tests and inspections.
   6. Description of the work and test and inspection method.
   7. Identification of product and specification section.
   8. Complete test or inspection data.
   9. Test and inspection results and an interpretation of test results.
   10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
   11. Comments or professional opinion on whether tested or inspected work complies with the contract document requirements.
   12. Name and signature of laboratory inspector.
   13. Recommendations on retesting and re-inspecting.

B. Manufacturer's technical representative's field reports: prepare written information documenting manufacturer's technical representative's tests and inspections specified in other sections. Include the following:
   1. Name, address, and telephone number of technical representative(s) making report.
   2. Statement on condition of substrates and their acceptability for installation of product.
   3. Statement that products at project site comply with requirements.
   4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
   5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
   6. Statement whether conditions, products, and installation will affect warranty.
   7. Other required items indicated in individual specification sections.

C. Factory-Authorized service representative's reports: prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other sections. Include the following:
   1. Name, address, and telephone number of factory-authorized service representative making report.
   2. Statement that equipment complies with requirements.
   3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
   4. Statement whether conditions, products, and installation will affect warranty.
   5. Other required items indicated in individual specification sections.

1.7 QUALITY ASSURANCE

A. General: qualifications paragraphs in this article establish the minimum qualification levels required; individual specification sections specify additional requirements.

B. Manufacturer qualifications: a firm experienced in manufacturing products or systems similar to those indicated for this project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Installer qualifications: a firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this project, whose work has resulted in construction with a record of successful in-service performance.

D. Professional architect and engineer qualifications: a professional architect or engineer who is legally qualified to practice in jurisdiction where project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or products that are similar to those indicated for this project in material, design, and extent.

E. Specialists: certain specification sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
   1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.

1.8 QUALITY CONTROL

A. The Seller responsibilities: tests and inspections not explicitly assigned to the Company are the Seller's responsibility. Perform additional quality-control activities required to verify that the work complies with requirements, whether specified or not.
   1. Notify the Company at least 48 hours in advance of time when work that requires testing or inspecting will be performed.
   2. Provide labor and technical support, annually calibrated (unless more frequent calibration is specified) and properly maintained equipment, and materials required to perform testing. Equipment calibration records shall be submitted upon request.
   3. Perform tests and inspections in a manner that allows observation by the Company.
   4. Submit a copy of tests performed within 48 hours after test completion.

B. Manufacturer's field services: where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 01 33 00 “Submittal Procedures”.

C. Retesting/Re-inspecting: regardless of whether original tests or inspections were the Seller's responsibility, provide quality-control services, including retesting and re-inspecting, for construction that replaced Work that failed to comply with the Contract Documents.

D. Coordination: coordinate sequence of activities to accommodate required quality-assurance and control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
   1. Schedule times for tests, inspections, obtaining samples, and similar activities.

PART 2 - NOT USED

PART 3 - TECHNICAL REQUIREMENTS

3.1 TEST AND INSPECTION LOG

A. Prepare a record of tests and inspections. Include the following:
   1. Date test or inspection was conducted.
   2. Description of the Work tested or inspected.
   3. Date test or inspection results were transmitted to the Company.
   4. Identification of testing agency or special inspector conducting test or inspection.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are the Seller's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 01 40 00

SECTION 01 41 00 – REGULATORY REQUIREMENTS - WORK SMART STANDARDS (WSS)

PART 1 - PROJECT REQUIREMENTS

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. WSS reference the latest edition unless otherwise noted.

PART 2 - CODES AND STANDARDS

2.1 WORK SMART STANDARDS

A. Work Smart Standards are listed in the following:
1. Section 01 41 00.01 Work Smart Standard 1. WSS for Other Industrial, Radiological, and Non-Radiological Hazard Facilities
2. Section 01 41 00.02 Work Smart Standard 9. WSS - Engineering Design of Standard Industrial, Radiological, Non-Reactor Category 2 & 3 Nuclear, and Accelerator Facilities
3. Section 01 41 00.03 Work Smart Standard 8. WSS for Construction and Construction-like Activities

END OF SECTION 01 41 00

SECTION 01 41 00.01 –WORK SMART STANDARDS (WSS) GROUP 1

SBMS

ORNL Work Smart Standards

1. Other Industrial, Radiological, and Non-Radiological Hazard Facilities (Approved 07-25-1996) through Rev/Change 109 (01-29-2020)

Many of the listed directives have embedded (referenced) standards which must be reviewed for applicability. Additionally, applicable SBMS subject areas must be reviewed to ensure all applicable requirements are implemented.

Notes / Implementation Assumptions / Exceptions / Deviations are listed at the end of the WSS list below.

10 CFR 1021, National Environmental Policy Act (NEPA) Implementation Procedures
10 CFR 1022, Compliance with Floodplain/Wetlands Environmental Review Requirements
10 CFR 820, Procedural Rules for DOE Nuclear Activities
10 CFR 830, Subpart A, Quality Assurance Requirements
10 CFR 835, Occupational Radiation Protection
10 CFR 850, Chronic beryllium Disease Prevention Program
10 CFR 851 (with notes), Worker Safety and Health Program
10 CFR 962, By-product Material
18 CFR 1304, Approval of Construction in the Tennessee River System
25 USC 3001 et seq, Native American Graves Protection & Repatriation Act
29 CFR 1977, Discrimination Against Employees Exercising Rights under the Williams-Steiger Occupational Safety & Health Act of 1970
33 CFR 320-323; 328-330, Corps of Engineers Waters Requirements
36 CFR 60, National Register of Historic Places
36 CFR 63, Determination of Eligibility for Inclusion in the National Historic Places
36 CFR 65, National Historic Landmarks Program
36 CFR 78, Waiver of Federal Agency Responsibilities under 110 of NHPA
36 CFR 79, Curation of Federally Owned & Administered Archaeological Collections
36 CFR 800, Protection of Historic & Cultural Properties
39 CFR 111.1, General Information on Postal Service
40 CFR 104-149, Implementing Regulations for Federal Water Pollution Control Act & Safe Drinking Water Act
40 CFR 1500-1508, Council on Environmental Quality
40 CFR 156, Labeling Requirements for Pesticides & Devices
40 CFR 162, State Registration of Pesticide Products
40 CFR 166, Exemption of Federal & State Agencies for Use of Pesticides Under Emergency Conditions
40 CFR 170, Worker Protection Standard
40 CFR 171, Certification of Pesticide Applicators
40 CFR 232, Program Definitions; Exempt Activities Not Requiring 404 Permits
40 CFR 260-280, Federal Hazardous Waste Regulations
40 CFR 302, Designation, Reportable Quantities & Notification
40 CFR 311, Worker Protection
40 CFR 355, Facility Notification & Release Reporting Requirements
40 CFR 370, Hazardous Chemical Inventory Reporting Requirements
40 CFR 372, Toxic Release Reporting Requirements
40 CFR 373, Reporting Hazardous Substance Activity when Selling or Transferring Federal Real Property
40 CFR 50-99, CAA Implementing Regulations
40 CFR 503, Standards for Use/Disposal of Sewage Sludge
40 CFR 720, Premanufacturing Notices
40 CFR 761, PCBs Manufacturing, Processing, Distribution in Commerce and Use Prohibitions
40 CFR 763, Asbestos
41 CFR 102-34, Subpart D (102-34.220 through .250; Subpart E 102.34.255 through .260), Official Use of Government Vehicles

41 CFR 109-38.5102(c), Utilization Controls and Practices
41 CFR 109-6.400-50(h), Instructions to DOE Passenger Carrier Operations
42 CFR 73, Possession, Use, and Transfer of Select Agents and Toxins
42 USC 2011 et seq., Atomic Energy Act of 1954
42 USCA 13101-13109, Pollution Prevention Act
42 USCA 300f to 300j-26, Safe Drinking Water Act
42 USCA 9601-9675, Comprehensive Environmental Response, Compensation & Liability Act
43 CFR 7, Protection of Archaeological Resources
49 CFR 106-199, U.S. Department of Transportation (DOT) Hazardous Materials Regulations
49 CFR 325-399, DOT Federal Motor Carrier Safety Regulations
49 USC 1813 et seq, Hazardous Materials Transportation Act
50 CFR 1-697, Wildlife and Fisheries, as applicable
7 CFR 301, Domestic Quarantine Notices
7 CFR 318, Hawaiian & Territorial Quarantine Notices
7 CFR 319, Foreign Quarantine Notices
7 CFR 330, Subparts A, B, C (§ 100-302), Federal Plant Pest Regulations; General; Plant Pests; Soil, Stone, and Quarry Products; Garbage
7 CFR 331, Agricultural Bioterrorism Protection Act of 2002;
7 CFR 340 , Introduction of Organisms and Products Altered or Produced Through Genetic Engineering Which are Plant Pests or Which There is Reason to Believe are Plant Pests
7 CFR 352, Plant Quarantine Safeguard Regulations
7 USCA 136-136y, Federal Insecticide, Fungicide, & Rodenticide Act
9 CFR 1-3, Animals and Animals Products
9 CFR 121, Possession, Use and Transfer of Biological Agents and Toxins
ANSI/ITSDF B56.6 (2016), Safety Standard for Rough Terrain
Army Regulation (AR 385-63), Policies & Procedures for Firing Ammunition for Training, Target Practice and Combat
ASME A17.1-2010, Safety Code for Elevators and Escalators, with implementation assumptions
ASME A17.3-2017, Safety Code for Existing Elevators and Escalators, with implementation assumptions
ASME B30.9 (2018), Slings (equipment design specification only)
ASME NQA-1-2000, Part II, Subpart 2.7, Quality Assurance Requirements for Nuclear Facility Applications, Subpart 2.7, Quality Assurance Requirements for Computer Software for Nuclear Facility Applications
ASME Standard NQA-1-2000, Part 1, Quality Assurance Requirements for Nuclear Facility Applications (Contract Work Smart Standards for HFIR and Non-reactor Nuclear Facilities only)
ASNT SNT-TC-1A, Qualification of Nondestructive Testing Personnel
AWS B2.1, Specification for Welding Procedure and Performance Qualification
AWS D1.1, Welding Code-Steel
AWS D1.2, Structural Welding Code-Aluminum
AWS D1.3, Structural Welding Code-Sheet Steel
AWS D1.6, Structural Welding Code-Stainless Steel
AWS D9.1, Sheet Metal Welding Code
AWS QC-1, Specification for Qualification and Certification of Welding Inspectors
AWWA D100, Welded Steel Tanks for Water Storage
DOE M 435.1-1, Administrative Change 2, Radioactive Waste Management Manual
DOE O 151.1D, Attachment 1, (with Implementation Assumptions), Comprehensive Emergency Management System
DOE O 153.1, Departmental Radiological Emergency Response Assets; Attachment 2 (with the exception of Sections 3, 4, 5, 7, 11, and 13 which are not applicable)
DOE O 231.1B, Administrative Change 1, Environment, Safety and Health Reporting
DOE O 232.2A, Occurrence Reporting and Processing of Operations Information
DOE O 414.1D, Administrative Change 1, Quality Assurance
DOE O 420.1C, Change 2, Facility Safety; Compliance Line, Implementation Plan submitted to DOE 12/17/2018
DOE O 420.1C, Change 2; Attachment 2, Chapter 1, Facility Safety; Nuclear Safety Design Criteria;
DOE O 420.1C, Change 2; Attachment 2, Chapter II, with Implementation Assumptions, Facility Safety; Fire Protection;
DOE O 420.1C, Change 2; Attachment 2, Chapter IV, with Implementation Assumptions, Facility Safety; Natural Phenomena

4/20/2020 WSS for Other Industrial, Radiological, and Non-Radiological Hazard Facilities

Hazards Mitigation

DOE O 420.1C, Change 2: Attachment 2, Chapter V, Facility Safety: Cognizant System Engineer Program

DOE O 440.2C, Administrative Change 1, Aviation Management and Safety

DOE O 443.1B, Administrative Change 1, Protection of Human Research Subjects

DOE O 456.1A, The Safe Handling of Unbound Engineered Nanoparticles

DOE O 458.1, Administrative Change 3, Radiation Protection of the Public and the Environment

DOE O 460.1D , Hazardous Materials Packaging and Transportation Safety

DOE O 460.2A, Departmental Materials Transportation and Packaging Management

DOE-STD-1090-2011 with exceptions, Hoisting and Rigging

DOE-TEMA Emergency Management Coordination (With Assumptions), Agreement Between the United States Department of Energy and the State of Tennessee for Emergency Management Coordination, Dated November 19, 2019

Executive Order 11988, Floodplain Management

Executive Order 11990, Protection of Wetlands

MUTCD, Manual on Uniform Traffic Control Devices

NBIC, National Board Inspection Code (for existing and new pressure vessels) (The latest edition of the NBIC is to be used (see NBIC Foreword for specific applicability).

Pelletier Letter, Table 1, Surface Activity Guidelines (and footnotes)

Public Law 102-579, WIPP Land Withdrawal Act of 1992, as amended (P.L. 102-579

Tenn Code 1200-01-20, Asbestos Accreditation Requirements

Tenn. Code Ann. 43-8-101 et seq, Tennessee Insecticide, Fungicide & Rodenticide Act

Tenn. Code Ann. 62-21-101 et seq, Tennessee Application of Pesticides Act

Tenn. Code Ann. 65-15-101 et seq, Motor Carriers

Tenn. Code Ann. 68-120-101 et seq, Statewide building construction safety standards

Tenn. Code Ann. 68-14-301 , Hotels, Food Service Establishment & Public Swimming Pool Inspection Act of 1985

Tenn. Code Ann. 68-140-307, Standards for Vehicles and Equipment

Tenn. Code Ann. 68-216-101 et seq, Tennessee Oil Spill Cleanup & Environmental Preservation Act

Tenn. Code Ann. 69-9-201 et seq, Tennessee Boating Safety Act of 1965

Tenn. R. & Reg. 0080-6-14, Pest Control Operators

Tenn. R. & Reg. 0080-6-16, Regulations Governing Use of Restricted Use Pesticides

Tenn. R. & Reg. 0400-11-01, Solid Waste Processing & Disposal

Tenn. R. & Reg. 0400-12-01, Hazardous Waste Management

Tenn. R. & Reg. 0400-18-01, Underground Storage Tank Program

Tenn. R. & Reg. 0400-40, Tennessee Water Quality Regulations

Tenn. R. & Reg. 0400-45-01, Public Water Systems

Tenn. R. & Reg. 0400-48-01, Regulation to Govern Subsurface Sewage Disposal Systems

Tenn. R. & Reg. 1200-12-01, Rules of the Tennessee Department of Health, Bureau of Health Licensure and Regulation, Division of Emergency Medical Services, General Rules

Tenn. R. & Reg. 1200-23-1, Rules Governing Food Service Establishments

Tenn. R. & Reg. 1200-3, Division of Air Pollution Control Regulations

Tenn. R. & Reg. 1340-6-1 (formerly listed as 1220-2-1), Rules and Regulations as to Supervision and Control of Motor Vehicles and Motor Buses

Tenn. R. & Reg. 1660-01-32, Wildlife Resources

END OF SECTION 01 41 00

SECTION 01 41 00.02 –WORK SMART STANDARDS (WSS) GROUP 8

SBMS
ORNL Work Smart Standards

8. Construction and Construction-like Activities
(Approved 05-07-1997) through Rev/Change 13 (09-28-2018)

Many of the listed directives have embedded (referenced) standards which must be reviewed for applicability. Additionally, applicable SBMS subject areas must be reviewed to ensure all applicable requirements are implemented.

Notes / Implementation Assumptions / Exceptions / Deviations are listed at the end of the WSS list below.

The necessary and sufficient standards set approved for the Other Industrial, Radiological and Non-Radiological Hazard Facilities are approved for use in Construction and Construction-like Activities plus the following additional standards *(Where 1926 is inadequate or silent, appropriate general industrial standards found in 1910, an already accepted standard, will be incorporated)*:

ANSI/SIA A92.2 (1990), American National Standard for Vehicle-Mounted Elevating and Rotating Aerial Devices (equipment design specification only)

DOE O 420.1C, Change 2; Attachment 2, Chapter 1, Facility Safety; Nuclear Safety Design Criteria;

DOE O 425.1D, Administrative Change 1, Verification of Readiness to Start Up or Restart Nuclear Facilities

END OF SECTION 01 41 00.02

SECTION 01 41 00.03 –WORK SMART STANDARDS (WSS) GROUP 9

SBMS
ORNL Work Smart Standards

9. Engineering Design of Standard Industrial, Radiological, Non-Reactor Category 2 and 3 Nuclear, and Accelerator Facilities
(Approved 04-14-1998) through Rev/Change 16 (09-28-2018)

Many of the listed directives have embedded (referenced) standards which must be reviewed for applicability. Additionally, applicable SBMS subject areas must be reviewed to ensure all applicable requirements are implemented.

Notes / Implementation Assumptions / Exceptions / Deviations are listed at the end of the WSS list below.

Engineering design activities for a given ORNL facility will utilize the WSS set for Other Industrial, Radiological, and Non-Radiological Hazard Facilities; the WSS set for Construction and Construction-like Activities; and the WSS for the given facility plus the following additional standards:

Note: This WSS Set applies to new designs, facility modifications, and equipment installations that pertain to facility modifications.

Standard Industrial Facility:

1 CFR 436, Federal Energy Management and Planning Programs. (The hazards that this law addresses are not directly related to ES&H issues but applicable to engineering design.)

23 CFR 625, Design Standard for Highways

23 CFR 655, Traffic Operations

4 CFR 4 3, General Pretreatment Regulations for Existing and New Sources of Pollution. (ORNL at Y-12 only)

ASME N5 9, Nuclear Power Plant Air Cleaning Units and Components, 1989

AWS QC-1, Specification for Qualification and Certification of Welding Inspectors

DOE O 42 .1C, Change 2: Attachment 2, Chapter IV, with Implementation Assumptions, Facility Safety: Natural Phenomena Hazards Mitigation

FED-STD-795, Uniform Federal Accessibility Standards

Instrument Society of America (ISA) 5.1, Instrument Society of America (ISA) 5.1, Instrumentation Symbols and Identification, 2 9

Instrument Society of America (ISA) 5.4, Instrument Society of America (ISA) 5.4, Instrument Loop Diagrams, 1991

International Building Code (IBC), 2 12, International Building Code (IBC), 2 12: Exceptions: All Appendices and replace all references to the ICC Electrical Code with the NFPA 7   National Electrical Code, latest edition. (See WSS Set #9, Implementation Assumption #6 for coordination of requirements from DOE Standard 1 2 -2 16.)

International Fire Code (IFC) 2 12 , International Fire Code, 2 12: Exception: Appendix A – Board of Appeals. Include Appendix B through I as reference only.

International Fuel Gas (IFG) Code, 2 12 , International Fuel Gas (IFG) Code, 2 12 – Exception: Appendix A, Include Appendix B through I as reference only.

International Mechanical Code (IMC), 2 12 , International Mechanical Code (IMC), 2 12 Exceptions: All Appendices

International Plumbing Code (IPC), 2 12, International Plumbing Code, 2 12 – Exception: Appendix A, Include Appendix B through G as reference only.

National Association of Corrosion Engineers (NACE) RPO 169-92, Control of External Corrosion on Underground or Submerged Piping Systems

Public Law 1 1-336, Americans with Disabilities Act (ADA)

Note: International Building Codes (I-Codes) 2012 WSS Report, Attachments C and D, includes additional information to describe applicability of the I-Codes and how the Chapter 1 (Administration) sections of the specific codes are applied at ORNL: WSS Building Codes Report. The implementing matrices in Attachment D will also be made available in the Standards Based Management System (SBMS) Engineering Management System Subject Area for Design.

END OF SECTION 01 41 00.03

SECTION 01 42 16 – DEFINITIONS

PART 1 - PROJECT REQUIREMENTS

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

PART 2 - CODES AND STANDARDS

2.1 DEFINITIONS

A. Company: UT Battelle, LLC.
   1. The Company is the Code Authority and the Authority Having Jurisdiction.

B. Seller: Design/Build (D/B) offeror responsible for the design and construction of the project in accordance with these D/B Performance Specifications and the CFCs (contract documents).

C. A-E: An Architectural firm currently licensed in the state of Tennessee and normally engaged in architectural work inclusive of the Architectural firm's Consulting Engineers currently licensed in the state of Tennessee and normally engaged in engineering design work, and any specialty Consultants, under contract with the Seller.

D. Contract Documents, Certified for Construction (CFC): Contract documents issued, signed and professionally stamped by the A-E.

E. Atlas Sheets: Drawings depicting utilities and subsurface interferences exterior to ORNL Buildings. The contents and accuracy of these drawings must be verified in the field.

F. Work Smart Graded Approach: A scaled approach recognizing that projects and engineering efforts may vary significantly in size, complexity and technical challenges. The use of reasonableness and common sense should be considered in applying this design criteria.

G. Standards (WSS): Codes/Standards required as part of the UT Battelle contract with DOE.

H. Square Footages.
   1. The Standard Method for Measuring Floor Area in Office Buildings, ANSI/BOMA Z65.1, shall be used for calculating square footages.
      a. Net Usable Square Footage.
         1) Programmed square footage that meets the user requirements as specified in the room data sheets. Net usable square footage does not include walls enclosing program spaces.
      b. Gross Square Footage.

1) The area encompassed by the exterior dimensions of the facility at each floor level, not to include any open roof area. Upper levels of two-story spaces and exterior decks are to be included at one-half the actual square footage.

c. Utilization Efficiency.

1) The ratio of net square feet to gross square feet of a facility (expressed as a percentage) is a measure of space utilization efficiency. In office buildings, the utilization efficiency is about 75 percent. Project specific utilization efficiency target is 90% percent.

PART 3 - NOT USED

END OF SECTION 01 42 16

SECTION 01 55 00 – ENVIRONMENTAL PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Specification Section 010100, General Work Requirements.

B. Specification Section 011100, Safety and Health.

C. Specification Section 011500, Radiological Protection.

D. Specification Section 015000, Temporary Facilities and Site Controls.

E. Specifications Section 017419, Demolition Waste Management and Disposal.

1.2 ATTACHMENTS

A. Attachment 1, Oak Ridge National Laboratory (ORNL) Environmental Management System (EMS) Awareness Training for Construction and Service Contractors.

B. Attachment 2, NOT USED.

C. Attachment 3, Managing Construction Waste Waters.

D. Attachment 4, NOT USED.

1.3 REFERENCES

A. Environmental Protection Agency (EPA) 40 Code of Federal Regulations (CFR) 260 – 280 and Tennessee (TN) Rule 0400-12-01.

B. The EPA, Designation, Reportable Quantities and Notification, 40 CFR 302.

C. The EPA, National Emission Standards, Hazardous Air Pollutants, 40 CFR 61 & 40 CFR 63; and TN Rules 1200-3-8, Fugitive Dust, and 1200-3-11, Asbestos.

D. Solid Waste Processing and Disposal, TN Rule 0400-11-01.

E. EPA Protection of Stratospheric Ozone, 40 CFR 82.

1.4 DEFINITIONS

A. Environmental protection: the prevention/control of pollution and habitat disruption that may occur to the environment during construction. The control of environmental pollution and damage requires consideration of land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise, solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other pollutants.

B. Resource Conservation and Recovery Act (RCRA) hazardous waste: any discarded material that is not excluded by 40 CFR Part 261.4(a) and that is listed in 40 CFR Subpart D or exhibits any of the characteristics identified in 40 CFR 261 Subpart C.

C. Respiratory hazard wastes: fiberglass with loose fibers, mineral wools, slag wools, rock wools, and other manmade mineral fiber material.

D. Sanitary waste: waste generated by offices, cafeteria, medical facilities and laboratories, and includes textile products (personal protective equipment [PPE], coveralls, cotton items, carpet, etc.).

E. Special waste: wastes that are either difficult or dangerous to manage such as friable or non-friable asbestos, empty aerosol or paint containers, petroleum contaminated soil, bulk product PCB waste, PCB remediation wastes, etc.

1.5 TRAINING

A. All on-site personnel performing work activities with potential to negatively impact the environment shall be provided with environmental awareness training in accordance with requirements of the ORNL EMS. The attached electronic file (Attachment 1) represents the minimum level of EMS Awareness Training to be provided to construction and subcontract workers. The training shall be provided by the Seller as part of the initial employee site orientation and Environment, Safety and Health (ES&H) briefing.

B. The Sellers, their subcontractors and all employees who use hazardous materials and may generate or handle a hazardous waste, must provide evidence of having received RCRA Hazardous Waste Awareness Training and annual refresher training as required by 40 CFR 265.16 and 262.34 prior to starting any work involving these items.

1.6 SUBMITTALS

A. Submit names and certification documentation for the Tennessee Department of Environment and Conservation (TDEC) Level 1 Erosion Prevention & Sediment Control (EP&SC) inspector to be used for the project. Must be submitted and approved by the Company prior to the start of work.

B. Submit the completed and signed TDEC Inspection Forms at project completion.

C. Submit for approval, a list of non-storm water/waste water streams that are anticipated to be generated and the treatment and disposal methods for each stream. This must be approved by the Company prior to the start of work.

1.7 REQUIREMENTS TO COMPLY WITH APPLICABLE LAWS AND REGULATIONS

A. The Seller shall provide written proof of registration, licensing, insurance, or other requirements upon request. It is the Seller's responsibility to ascertain and comply with all applicable federal, state, local and multi-jurisdictional laws, ordinances, and regulations pertaining to the registration, licensing, handling, transportation, packaging, management, processing, resale and disposal of these materials under this contract. These federal, state, and local laws include but are not limited to the Clean Air Act; the Toxic Substances Control Act; the Atomic Energy Act; the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA); the Hazardous Materials Transportation Regulations; the Federal Motor Carrier Safety Regulations; the Tennessee Motor Vehicle Laws Annotated; the Emergency Planning and Community Right-to-Know Act, 40 CFR 279; and TDEC Rule Chapter 0400-12-01-.11.

PART 2 - ENVIRONMENTAL PROTECTION

2.1 PERMITS

A. Conduct all work so as to comply with applicable permits and regulatory requirements. The Company will identify the applicable permits and other regulatory requirements.

2.2 GENERAL REQUIREMENTS

A. Placement of fuel or oil storage tanks on-site is not allowed. Fluids needed for construction equipment shall be provided by off-site delivery trucks, as needed.

B. The Seller shall minimize environmental pollution and damage that may occur as the result of demolition, renovation and/or any other construction operations.

C. The Seller shall address environmental issues, potential negative impacts, and appropriate control measures in the Hazards Analysis (per Specification 011100) and discuss these topics during site orientation and pre-job briefings.

D. Conduct all work that generates waste requiring disposal so as to comply with waste acceptance criteria of the disposal facility, in a manner that avoids negative impacts to operational or compliance status of the disposal facility.

E. The Seller’s personnel shall be cognizant of all aspects of environmental protection applicable to the Seller’s work activities, including, but not limited to storm water pollution prevention and control, spill prevention and control, erosion and sediment control, fugitive dust and air emission control, and waste management requirements.

F. Pollution prevention and waste minimization principles shall be incorporated in abatement and demolition activities to ensure the greatest environmental benefits and minimize future liability for the waste that is generated.

G. Comply with all requirements of Section 017419, Demolition Waste Management and Disposal, including but not limited to the implementation of work planning and work practices to facilitate, where feasible, the recycle and/or salvage of at least 50% of non-hazardous construction and demolition debris.

2.3 SPILL PREVENTION

A. Petroleum products stored in quantities greater than or equal to 55 gallons shall be appropriately labeled and have secondary containment capable of preventing any release to a drainage system or the environment. Secondary containment shall be configured so as to capture leaks and spills from both dispensing equipment and/or container(s). Containers 55 gallons or greater that store oil or Hazardous Substances (40 CFR 116 and 40 CFR 302) must comply with the requirements in the ORNL Spill Prevention Control and Countermeasures (SPCC) Plan.

B. Prior to mobilization to the site, perform an inspection of equipment containing liquid systems including, but not limited to, bulldozers, backhoes, bobcats, drill rigs, trucks, hoists, and cranes, to ensure no leaks exist. Verify hoses, tubing, and hydraulic lines are in good operating condition. Make all necessary repairs before delivery of equipment or vehicles to the construction site.

C. Perform daily inspections to ensure continued good operating condition of equipment and promptly repair all deficiencies. The Seller shall maintain documentation of inspections and provide to the Company upon request.

D. Use due caution when operating oil-bearing equipment near aquatic resources. Where necessary, implement appropriate control measures, including but not limited to the use of physical barriers (plastic or tarps, berms, etc.) and/or absorbent materials to prevent leaks or spills from entering waterways.

E. Use due caution when refueling vehicles or equipment, transferring fuels or other liquids to or from containers; have spill kit on hand for immediate cleanup as necessary. Avoid performing such transfer of fuels near streams or storm water inlets.

F. Flushing empty concrete trucks or dumping excess concrete is prohibited. Transport excess concrete back to the batch plant. The truck chute may be washed onsite within a concrete washout box (constructed in accordance with the Tennessee Erosion and Sediment Control Handbook - latest edition) or at an off-site location approved by the Company. Solidified cement waste from truck chute cleaning is solid waste and shall be removed from the site, and properly disposed per Company approved locations.

2.4 SPILL CONTROL AND CLEAN-UP

A. When on-site, all personnel shall report spills of any hazardous substance and chemical/radiological releases. The Laboratory Shift Superintendent's (LSS) Office should be called for any spill or other emergency at 574-6606. Specially trained spill response teams clean up all types of spills at ORNL, including oil, hazardous substances, and hazardous waste and are available on shift 24 hours per day, 365 days per year. All spill response personnel have had, at a minimum the initial 24-hour Hazardous Waste Operations (HAZWOPER) Training. The Company will provide initial response; the Seller shall be responsible for all cleanup costs after initial response for activities caused by the Seller.

B. The person discovering a spill should give the following information to the LSS:

1. Type of spill if known (oil, gasoline, acid, base, etc.).
2. Estimated volume of the spilled material.
3. Location of the spill.
4. Extent of the spill.
5. Observer's location and telephone number.

C. For outside work, provide a spill kit, inspect equipment for leaks, and repair leaking equipment in a timely manner.

D. For inside work, provide a spill kit, prevent spills to floor drains and do not discharge waste into any ORNL systems without the Company approval.

2.5 STORM WATER POLLUTION PREVENTION AND CONTROL

A. Do not allow liquids, including but not limited to, gasoline, diesel fuel, lubricating oil, or antifreeze to enter the storm sewer systems, waterways, drainage ditches, or the ground.

B. Be aware of storm drain inlets and utilize appropriate control methods and or devices, and cover or contain debris stored outside. Seal interior drains, roof drains, and nearby area drains prior to demolition activities.

C. Tanks, drums, other containers, pumps and other dispensing units, and any secondary containment structures shall be located indoors, or under a canopy, or otherwise sheltered from contact with storm water in an appropriate and effective manner.

D. Store all materials indoors or otherwise protected from weather.

E. For outdoor painting operations, minimize overspray, and use tarps/vacuums/enclosures to contain sandblasting waste and paint chips from paint removal operations.

F. Prevent contamination of storm water by appropriate and effective control methods, such as daily removal of debris to the extent practicable, covering spoil material and debris piles from demolition or other activities, and otherwise diverting storm water from contact with same. Implement other effective controls to detain and filter or collect and treat waste waters generated by storm water contact with radiological or chemical contaminants. Controls shall be sized to handle the 25 year, 24 hour storm event.

G. Minimize the use of deicing compounds and other chemical surface treatments; application should be performed at the minimum effective rates.

H. Maintain a 60' minimum buffer zone from streams, be aware of storm drain inlets, and cover or contain debris stored outside.

I. The 90-day accumulation areas shall strictly adhere to requirements provided in Section 017419, "Demolition Waste Management and Disposal".

2.6 MANAGING WASTE WATER

A. Manage all waste waters in compliance with Attachment 3, "Managing Construction Waste Waters".

B. Water used to suppress dust during concrete cutting, demolition, or other activities shall not be discharged directly to storm drains, sanitary sewer, etc. Positive controls shall be used to protect drains from unfiltered discharges of this type. Water generated by demolition activities and decontamination that include Class 1 asbestos containing material (ACM) will require filtration to 10 microns or less for asbestos fibers. This also applies to water from showers provided for asbestos workers. A variance is required for disposal of this wastewater (refer to Attachment 3).

C. Unless otherwise directed by the Company, all chlorinated or treated water shall be discharged through a treatment/detention basin and monitored for chlorine levels, other contaminants when applicable, and standard water quality indicators. The treatment/detention basin may consist of a field-constructed structure or portable tank per the Seller's approved water management plan.

D. The Seller shall establish a hold point for the Company inspection of the Seller installed water diversion and collection system prior to initiation of demolition activities with the potential for release.

E. Storm water accumulated in demolition areas, chlorinated rinse water, and chlorinated water used to sterilize/flush pipelines shall not be directly discharged, or otherwise allowed to enter the storm systems, waterways, or drainage ditches without written approval from the Company.

F. Notify the Company at least one week prior to any activities that will generate waste water. The Seller's water management plan identifying the source and composition of the waste water, and describing the control methods to be used for management and disposal shall be approved prior to generating the water. Notify the Company prior to any discharge of water, waste water or other liquid material at least 24 hours in advance, then again immediately prior to initiating discharge.

2.7 EROSION AND SEDIMENT CONTROL

A. Appropriate temporary sediment controls will be in place prior to initiation of site clearing activities. Observe site conditions and inspect sediment controls at least twice weekly, and document the inspections using the "Construction Storm Water Inspection Certification (Twice-weekly Inspections)" Form at http://tnepsc.org/ (CGP drop down menu at this home page). A Level I E&SC inspector is required to complete these inspections, as noted in the instructions on the inspection form.

B. Appropriate effort will be made to avoid and/or mitigate damage to trees and shrubs adjacent to work activities. When it is deemed necessary to prune or remove branches from a tree or shrub (or when other damage occurs), the limb shall be cut off clean with chainsaw or other suitable device, and the wound dressed with an appropriate coating to mitigate future damage from insects or fungi.

C. Manage excavated soil and spoil material in a manner protective of the environment. Cover stockpiled material to prevent erosion and/or install appropriate sediment controls. Use due caution during excavation or any other soil management in the vicinity of sanitary or storm systems, waterways, or drainage ditches.

D. All erosion prevention measures and sediment controls shall comply with the Tennessee Erosion and Sediment Control Handbook (latest edition).

2.8 FUGITIVE DUST AND AIR EMISSION CONTROL

A. Equipment operation, activities, or processes performed by the Seller shall be in accordance with all federal, state, and local air pollution standards.

B. Asbestos debris shall be kept adequately wet in accordance with 40 CFR 61.

C. Use water mist, temporary enclosures, and other suitable methods to limit spread of dust and dirt.

D. Burning will not be allowed on the project.

E. Manage all equipment containing ozone-depleting substances (e.g. refrigerants) in accordance with the requirements of 40 CFR 82.

PART 3 - WASTE MANAGEMENT

3.1 WASTE MANAGEMENT REQUIREMENTS

A. The Seller shall comply with all waste management instructions provided by the Company, including but not limited to written specifications, drawing notes, waste management plans, policy or procedures, verbal instructions and waste accumulation area postings.

B. Substantive requirements for waste management planning and execution, landfill requirements, salvage and recycling goals and methods are provided within Section 017419, “Demolition Waste Management and Disposal”.

3.2 COPPER RIDGE SPOIL AREA

A. The Copper Ridge Spoil Area is an active area operated by UT-B that receives excavated materials from the ORNL campus which consist of only the following materials:

1. Clean soil (no radiation above normal background levels, no chemical contaminants above applicable cleanup levels)
2. Natural rock
3. Stumps
4. Concrete (can include rebar) – concrete cannot of any type of coating or paint on its surface

5. Brick rubble – brick cannot of any type of coating or paint on its surface

B. Pollutants from this area are storm water runoff that has come in contact with the above listed materials. The primary pollutant of concern is, therefore, sediment from soil erosion.

C. A meeting shall be held with the Company's Environmental Representative and the Seller prior to the start of the project to discuss erosion & sediment controls required at this spoil area and the particular area to place the project spoil materials. The Seller is expected to maintain and address issues associated with their activities at this spoil area, as required from inspections performed by the Company. Final stabilization of the area utilized by the Seller shall consist of grading the spoils per the Company's instructions and applying temporary seeding (grass type shall be as directed by the Company) and straw.

D. The spoil area is subdivided based on use by select Divisions within UT-B at ORNL. Therefore, a meeting with the UT-B Environmental Representative is required prior to the start of construction field activities in order to discuss the area to place spoil materials, erosion and sediment controls (E&SCs) required, etc. E&SCs will comply with the latest version of the Tennessee Erosion and Sediment Control Handbook.

E. The UT-B Environmental Representative will inspect the area utilized by the project one time per week and relay issues (i.e. E&SCs, tracking mud/dirt onto paved road, housekeeping, spoil not acceptable, etc.) to the Seller's representative. The Seller shall fix the issues within the 5 working days or the next rain event, whichever duration is shorter.

F. When on-site, all personnel shall report spills of any hazardous substance and chemical/radiological releases. Reporting requirements are within Section 015500-Environmental Protection.

END OF SECTION

ATTACHMENT 1

ORNL ENVIRONMENTAL MANAGEMENT SYSTEM AWARENESS TRAINING FOR CONSTRUCTION AND SERVICE SUBCONTRACTORS

I. POLLUTION

Water Pollution:
Release of pollutants directly into surface waters, or indirectly via storm water runoff, fuels, oil, chlorine, & other chemical products, uncured cement, erosion & sedimentation, etc.

Fish kills, impairment of water quality and aquatic habitat

Land Pollution:
Windblown litter from job sites and/or moving open bed trucks, improper management of chemical products and hazardous wastes

Air Pollution:
Fugitive dust from site grading, sandblasting, demolition, etc.

Many construction activities have potential to pollute the environment:

Refueling operations	Site clearing, grading and excavation
Spills & leaking equipment	Demolition & other dust-producing activities
Material handling & storage	Concrete finishing, cutting, concrete pumper and/or delivery chute flush out
Paint & coatings applications	Water line disinfection and flushing

II. CONSEQUENCES

Fines and penalties	Suspension of permits
Cost and schedule impacts	Work stoppage
Abatement measures	Corrective actions
Loss of eligibility to participate in future projects	Potential negative impacts to funding for future projects

III. PREVENTION

The ORNL Environmental Management System:

Applies to everyone whose work has the potential to impact the environment.

Requires that all workers be made aware of potential environmental consequences associated with their work activities, and use appropriate control measures.

Requires notification of Construction Field Representative (CFR) and LSS in response to spills and other environmental incidents or unusual conditions.

Environmental Requirements are communicated to Subcontractors:
To managers and supervisors through technical specifications, plans & drawings, electronic postings, correspondence, etc.

To individual workers, during site orientations and Hazard Analysis (HA) review, at ES&H briefings, and whenever assigning specific tasks that could result in a negative environmental impact.

Environmental Expectations:

Construction and Service Subcontractors are expected to:

- Plan, bid, and conduct work in accordance with specifications
- Communicate & enforce requirements with employees and with lower tier subcontractors.

Workers are expected to:

- Understand and comply with environmental requirements,
- Report unusual conditions and/or environmental incidents, and
  Consult supervision with any environmental concerns, questions, or observations

For the purposes of these guidelines, when a construction process utilizes water from any source, water that is not used up in the process (or lost by evaporation) should be considered to be wastewater.

Typical construction wastewaters include those listed below, although particular circumstances and/or site specific conditions may alter the nature of these wastewaters, or result in the generation of non-typical wastewaters not addressed under these guidelines. When project planners determine that non-typical wastewaters may be generated or discover that they have been, consultation with an Environmental Compliance Representative should take place as soon as practicable.

Mechanical construction activities:

M1. Pipeline draining
M2. Pipeline flushing
M3. Pipeline hydrostatic testing
M4. Pipeline disinfection

Civil construction activities:

C1. Removing accumulated storm water from trenches & other excavations or structures
C2. Flushing concrete truck chute and/or cleaning associated tools and equipment
C3. Water from high pressure washing and/or hosing down surfaces

Demolition activities:

D1. Asbestos worker shower facilities & tool decontamination
D2. Concrete cutting systems (blade coolant/dust suppression water)
D3. General dust suppression water

Work Activity	Wastewater description - potential contaminants	Method(s) of disposal	Applicable procedure or permit(s)
Table M Mechanical Construction Activities			
M1 - Draining non-wastewater piping systems	Rust preventative, algaecide, Chlorine (2 ppm or less), other chemical products, etc.	Accumulate, characterize, and dispose of as liquid hazardous waste when appropriate	SBMS, EM Subject Area: Environmental Management of Research and Operations – Procedure – “Managing Waste and Excess Materials”
		Sewage Treatment Plant (STP) or Process Waste Treatment Complex (PWTC)	Variance required SBMS, EM Subject Area: Environmental Management of Research and Operations – Procedure – “Clean Water Act”
	(waters exhibiting high temperature shall not be allowed to enter storm drains or surface water)	or discharge to upland area in a manner that prevents erosion (when approved by the Company)	General Permit for Storm Water Discharges from Construction Activities (TNR10-0000), Project Storm Water Pollution Prevention Plan
	(waters exhibiting high temperature shall not be allowed to enter storm drains or surface water)	or, if chlorine is known to be the only contaminant, discharge to storm drain system	Field verification of successful de-chlorination is required, ORNL Site Wide NPDES Permit (TN0002941)
Notes: Rust preventative & algaecide are considered non-hazardous at typical concentrations utilized in cooling water and other closed loop systems. Negative impacts to aquatic resources are possible, however, and care shall be taken to prevent release to surface waters. Chlorine is typically absent from existing systems other than potable or process water (i.e. chilled water, etc)			

Work Activity	**Wastewater description - potential contaminants**	**Method(s) of disposal**	**Applicable procedure or permit(s)**
Table M Mechanical Construction Activities			
M2 - Flush non-wastewater piping systems	Chlorine (2 ppm or less), nominal sediment, scale, etc.	STP or PWTC	Variance required SBMS, EM Subject Area: Environmental Management of Research and Operations – Procedure – "Clean Water Act"
		Or discharge to upland areas in a manner that prevents erosion – chemical treatment of discharge to remove chlorine – filtration as necessary to remove sediment/scale	General Permit for Storm Water Discharges from Construction Activities (TNR10-0000), Project Storm Water Pollution Prevention Plan
		or, if chlorine is known to be the only contaminant, discharge to storm drain system	Field verification of successful de-chlorination is required, ORNL Site Wide NPDES Permit (TN0002941)
Notes:			

Work Activity	Wastewater description - potential contaminants	Method(s) of disposal	Applicable procedure or permit(s)
Table M Mechanical Construction Activities			
M3 - Hydrostatic testing	Chlorine (2 ppm or less)	STP or PWTC	Variance required SBMS, EM Subject Area: Environmental Management of Research and Operations – Procedure – “Clean Water Act”
		or discharge to upland areas in a manner that prevents erosion – chemical treatment of discharge to remove chlorine	
		or, if chlorine is known to be the only contaminant, discharge to storm drain system	Field verification of successful de-chlorination is required, ORNL Site Wide NPDES Permit (TN0002941)
Notes:			

Work Activity	Wastewater description - potential contaminants	Method(s) of disposal	Applicable procedure or permit(s)
Table M Mechanical Construction Activities			
M4 - Disinfect piping systems	Chlorine (50 – 200+ ppm)	Discharge to STP, PWTC (Collection and pre-treatment may be required)	Variance required SBMS, EM Subject Area: Environmental Management of Research and Operations – Procedure – “Clean Water Act”
		or to treatment basin via suitable and effective de-chlorination system – monitor discharge and basin overflow for chlorine, pH, temperature, turbidity, etc. and halt or modify operations as needed	Field verification of successful de-chlorination is required, ORNL Site Wide NPDES Permit (TN0002941)
Notes: Heavily chlorinated water is extremely toxic to aquatic systems; exceptional care shall be taken to prevent release of untreated or insufficiently treated water to the environment. Overflow from treatment basin shall be released onto a suitable upland area (or storm drain system, if necessary) only after verification of acceptable de-chlorination and other water quality parameters			

Work Activity	**Wastewater description - potential contaminants**	**Method(s) of disposal**	**Applicable procedure or permit(s)**
Table C Civil Construction Activities			
C1 - Dewatering excavations	Sediment, suspended solids, chemical or radiological contaminants (previously existing or due to construction activities)	Filtration, discharge to STP or PWTC	Variance required SBMS, EM Subject Areas: Environmental Management of Research and Operations – Procedure – “Clean Water Act” & “Managing Waste and Excess Materials”
		Or, Filtration and discharge to vegetated upland areas taking care to ensure that pump intake does not agitate water within the excavation, discharging to upland areas through filtration and in a manner that prevents erosion	By approval of Construction Field Representative (CFR) and FDD Environmental Representative (ER) General Permit for Storm Water Discharges from Construction Activities (TNR10-0000), Project Storm Water Pollution Prevention Plan
Notes: Excavations associated with construction or maintenance of potable water lines or other liquid-carrying pipelines may present with chlorine or other potential contaminants which must be addressed on a case by case basis. The presence of regulated contaminants in excavation water or adjacent soils requires investigation by EP Staff prior to disposition.			

Work Activity	Wastewater description - potential contaminants	Method(s) of disposal	Applicable procedure or permit(s)
		Table C **Civil Construction Activities**	
C2 - Flushing concrete truck chute/cleaning tools	Moderate alkalinity, Chlorine (2 ppm or less), suspended solids	Discharge to STP, PWTC,	Variance required SBMS, EM Subject Area: Environmental Management of Research and Operations – Procedure – "Clean Water Act"
		or upland areas, followed up by removal of cured concrete residues cement-contaminated water shall not be released into storm drains or surface water, or runoff otherwise allowed beyond the construction site boundaries	By approval of Construction Field Representative (CFR) and FDD Environmental Representative (ER)
C3 - Pressure washing surfaces	Chlorine (2 ppm or less), suspended solids	Discharge to STP	Variance required SBMS, EM Subject Area: Environmental Management of Research and Operations – Procedure – "Clean Water Act"
		or upland areas, collect/filter prior to entering aquatic features	(TNR10-0000), Project SWPPP
Notes: No detergent or other cleaning agent allowed where runoff may reach aquatic features! Chlorine typically absent from tank-stored water and/or lost during use due to agitation, exposure to sunlight and wind. Prevent contamination of storm water runoff or other surface water sources due to contact with uncured cement and/or other suspended solids			

Work Activity	**Wastewater description - potential contaminants**	**Method(s) of disposal**	**Applicable procedure or permit(s)**
Table D Demolition Activities			
D1 - Asbestos worker showers & tool decontamination	Asbestos, Chlorine (2 ppm or less)	HEPA filtered (5 micron or better) & discharged to STP.	Variance required SBMS, EM Subject Area: Environmental Management of Research and Operations – Procedure – "Clean Water Act"
Notes: Discharge permitted under NESHAP when HEPA filtered and disposed to Sewage Treatment Plant			
D2 - Concrete cutting blade coolant/dust suppression	Moderate alkalinity, Chlorine (2 ppm or less), suspended solids	Discharge to STP or PWTC	Variance required SBMS, EM Subject Area: Environmental Management of Research and Operations – Procedure – "Clean Water Act"
		or to upland areas, collect/filter prior to entering aquatic features	(TNR10-0000), Project SWPPP
D3 - General dust suppression	Chlorine (2 ppm or less)	Discharge to upland areas, collect/filter prior to entering aquatic features	
Notes: Chlorine typically lost during water use due to agitation, exposure to sunlight and wind, depending upon volumes and flow rates. Monitor runoff and treat discharge as necessary to remove chlorine and/or suspended solids. Prevent runoff to storm drains or surface water if pH is determined to be above 8.5			

END OF SECTION 01 55 00.03

SECTION 01 74 19 – DEMOLITION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 ATTACHMENTS

A. Attachment 1, Oak Ridge Reservation Master Profile S-010, Rev 3, Construction/Demolition Waste, Effective 10/01/2012

B. Attachment 2, Oak Ridge Reservation Master Profile S-050, Rev 3, Spoil Materials, Effective 10/01/2012

C. Attachment 3, Landfill Prohibited Waste Items

D. Attachment 4, Prohibited Items for Metal Recycle

1.2 DEFINITIONS

A. Sanitary waste: waste generated by offices, cafeteria, medical facilities and laboratories, and includes textile products (personal protective equipment [PPE], coveralls, cotton items, carpet, etc.).

B. Construction waste: building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

C. Demolition waste: building and site improvement materials resulting from demolition or selective demolition operations.

D. Disposal: removal off-site of demolition and construction waste and subsequent recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

E. Recycle: recovery of demolition waste (i.e., metals, electronics) for subsequent processing in preparation for reuse.

1.3 TRAINING

A. The Sellers, their subcontractors and all employees who use hazardous materials and may generate or handle a hazardous waste, must provide evidence of having received RCRA Hazardous Waste Awareness Training and annual refresher training as required by 40 CFR 265.16 and 262.34 prior to starting any work involving these items.

1.4 REQUIREMENTS TO COMPLY WITH APPLICABLE LAWS AND REGULATIONS

A. The Seller shall provide written proof of registration, licensing, insurance, or other requirements upon request. It is the Seller's responsibility to ascertain and comply with all applicable federal, state, local and multi-jurisdictional laws, ordinances, and regulations pertaining to the registration, licensing, handling, transportation, packaging, management, processing, resale and disposal of these materials under this contract. These federal, state, and local laws include but are not limited to the Clean Air Act; the TSCA; the Atomic Energy Act; the Comprehensive Environmental Response, Compensation and Liability Act; the Hazardous Materials Transportation Regulations; the Federal Motor Carrier Safety Regulations; the TN Motor Vehicle Laws Annotated; the Emergency Planning and Community Right-to-Know Act, 40 CFR 279; and TDEC (Tennessee Department of Environment and Conservation) Rule Chapter 1200-1-11-.11.

PART 2 - WASTE MANAGEMENT

2.1 WASTE MANAGEMENT REQUIREMENTS

A. The Seller removal of Oak Ridge Reservation (ORR) landfill prohibited wastes must precede all excavation/demolition work.

B. Items prohibited from disposal at the ORR landfill must be removed from the buildings and affected areas prior to excavation/demolition. Instructions for managing the ORR landfill prohibited wastes are provided in Part 2.2 of this section.

C. The Seller is responsible for gross segregation of all waste items into the following potential categories as listed, if applicable.

D.

1. **Metal Recycle** – all scrap metal must be collected for the Company's approved metal recycle vendor. Work through the Company WM project lead will coordinate delivery and pickup of recycle metal containers. Both ferrous and nonferrous metals can be collected in the same secure container. Brass, bronze, and lead should be collected separately. See Attachment 4 for a list of prohibited items.

2. **Salvageable materials** – all excess property and salvaged materials must be processed by the Company's Excess Property Group before leaving the site (this includes palletized electronics for recycle), and the Company will provide assistance with this process. It is the Seller's responsibility to protect the property from pilferage and damage until it has been transported to the excess property/salvage area.

3. **Radiological-contaminated wastes streams** – all radiological-contaminated materials excluding Naturally Occurring Radioactive Materials (NORM). ***All packaging of radiological wastes will be done in the Company-provided***

containers. Waste packaging will be performed by the Seller under the supervision of the Company.

4. **Sanitary waste** – sanitary wastes are wastes generated by offices, cafeteria, medical facilities and laboratories, and include textile products (PPE, coveralls, cotton items, carpet, etc.). Typically, the waste is disposed of by the Company. The Seller shall bag garbage and deposit daily in the Company's dumpster.

NOTE: Where feasible, collect ALUMINUM CANS, PAPER, and CARDBOARD for RECYCLE. The Company will provide collection containers.

5. **Construction/Demolition debris –** these are wastes that result from construction, remodeling, repair and demolition of structures, and from road building or repair. These wastes include lumber, plastic, siding, paneling, flooring, windows, doors, and miscellaneous building demolition materials, brick, concrete, masonry materials, polyvinyl chloride (PVC) material, sheetrock/gypsum board, roofing materials, siding, paneling, flooring, and miscellaneous metals associated with demolition, windows, door, and miscellaneous building demolition materials. Attachment 1 provides the ORR landfill waste acceptance criteria for construction debris. Construction waste, as described in Section 1.2.B, consists of excess new materials (i.e., packaging) brought into the project by the Seller. It is the responsibility of the Seller to remove these materials because they are not eligible for disposition in the ORR landfill.

6. **Spoil materials** – uncontaminated excavated earthen-like materials such as soil, rock, gravel, concrete (without rebar), asphalt and clay material. Spoil materials will be sent to either the ORR landfill off Clear Spring Road or the on-site spoil facility, Copper Ridge. The Company will provide Seller with options for disposition of spoils at the project pre-bid kickoff meeting. Attachment 2 provides the ORR landfill waste acceptance criteria for spoil materials. Waste acceptance criteria for the Copper Ridge facility will be consistent with the ORR landfill requirements. The general requirements for loading and transportation of spoil materials at the Oak Ridge National Laboratory (ORNL) project site are outlined in Part 2.3.B of this section.

7. **Prohibited items –** special handling requirements for managing landfill prohibited items is provided in Part 2.2 of this section and a complete list of these items for the ORR landfill is provided in Attachment 3 of this section. The Company will ensure the proper management and disposal of these wastes and should be notified whenever items on the list are generated.

E. The Seller is responsible for ensuring that waste is sized so that it does not get stuck in transportation vehicles. Bulky items, i.e. pipe, concrete foundations, large storage tanks, structural steel, etc., must be less than 8' in length in order to permit safe handling with ORR landfill equipment.

F. If unexpected radiological materials are encountered during demolition, the Company will be responsible for the overall management and direction of the Seller's packaging operations on radioactive waste. The Company will manifest radioactive wastes, RCRA

Hazardous, and/or PCB waste. Waste from cleanup of spills may require being managed as a special or a hazardous waste. The Company will make this determination.

G. Instructions for managing ORR landfill eligible waste and the special handling requirements associated with each category of eligible wastes are provided in Part 2.3 of this section.

H. Any materials (solvents, paint, chemicals, etc.) brought on-site by the Seller will be removed by the Seller at the completion of the project INCLUDING EMPTY CONTAINERS, AND PARTIALLY FULL CONTAINERS.

I. The Seller shall provide containers and/or transport vehicles for ORR landfill eligible waste.

J. The Seller shall provide all of the materials (including bulk and non-bulk containers) required for the packaging, labeling, marking, and transportation of non-rad/non-hazardous wastes (including special wastes) to the ORR landfill in conformance with Department of Transportation (DOT) standards.

K. When a RCRA 90-day area has been established within the project boundary, the Company will be responsible for providing any necessary secondary containment (if applicable) and will provide covers/tarps for all drums within the 90-day area if necessary. If roll off or other open top containers are used for RCRA waste, the Company will provide the necessary tarps.

L. When a RCRA 90-day area has been established within the project boundary, the Seller shall ensure that all covers/tarps (with no holes, tears, or rips present) are in place over drums/small containers staged in the area. For roll off or larger open top containers, the Seller shall ensure the tarps are installed properly and any holes/rips in the tarps are repaired in-place. These actions shall be accomplished at the end of each workday and prior to any rain event. The Seller shall also ensure that secondary containment does not contain any liquids. The Seller shall promptly notify the Company of any observations of liquids in secondary containment.

M. The Seller shall provide containers and/or transport vehicles for ORR landfill eligible waste.

N. The Seller shall ensure the provision of respirators and PPE for personnel transporting Special Wastes (friable and airborne hazards) to the ORR landfill.

O. The Seller shall provide all of the materials (including bulk and non-bulk containers) required for the packaging, labeling, marking, and transportation of non-rad/non-hazardous wastes (including special wastes) to the ORR landfill in conformance with Department of Transportation (DOT) standards.

2.2 MANAGING ORR LANDFILL PROHIBITED WASTES

A. Landfill prohibited wastes are identified in Attachment 3 of this section.

B. The Seller shall request a radiological survey prior to attaching labels and green tags on all containers.

C. Free liquids.

1. Pumps, motors and HVAC units shall have plugs removed and water, oil and refrigerants drained prior to disposal. Hoses shall be cut and drained. All piping (e.g. fire protection and chilled water systems) shall be drained of free liquids.

2. Collect in containers provided by the Company. Always have 3” to 5” of empty space above volume of material when using drums for packing.

3. Provide identification of material added to containers (using log sheets) to permit safe opening, storage and handling by the Company.

4. Identify the type of waste and the date the container was filled and request survey of the container before removing it from the building.

5. Deliver green tagged containers to the Company WM lead for proper labeling and interim storage. .

2.3 CONTROL AND DISPOSAL OF ORR LANDFILL ELIGIBLE WASTE

A. Construction/Demolition (C/D) waste.

1. Remove C/D waste from the buildings and segregate from other wastes whenever possible.

2. The C/D wastes are wastes, typically other than special wastes, resulting from construction, remodeling, repair and demolition of structures, and from road construction and repair including, but not limited to:

a. Bricks.
b. Concrete and other masonry materials.
c. Soil.
d. Rock.
e. Lumber.
f. Road spoils.
g. Rebar.
h. Paving materials.
i. Vitrified clay materials (tile, pipe, block, etc.).
j. The PVC pipe.
k. Polyethylene sheeting.
l. Sheetrock/Gypsum board.
m. Roofing materials.
n. Styrofoam and neoprene insulation materials.
o. Building siding materials.
p. Paneling.

q. Flooring.
r. Miscellaneous metals associated with building demolition.
s. Window and door glass associated with building demolition.

3. Bulk handling and transport of C/D wastes:

a. Size and load the waste into the waste delivery vehicles in such a manner to prevent the waste from becoming lodged in waste delivery vehicles and containers (i.e., dump truck beds, dump trailers, roll-off containers) during the dumping operations. The Seller shall be responsible for safely removing and clearing lodged materials from the waste delivery vehicles/containers and all associated costs.
b. Waste delivery vehicles shall not be leaking fluids.
c. It is recommended that wastes be delivered in vehicles that are self-dumping/unloading. If it is absolutely necessary to deliver bulky and containerized wastes on flatbed trucks or trailers, the waste generator shall minimize the generation of such containerized and bulky wastes and shall perform advance coordination with the Landfill Operations Manager for the unloading.
d. All containers intended for disposal must be greater than 90% full (less than 10% void) except for 55 gallon or smaller containers, which can be safely compacted with landfill equipment.

4. Refer to Master Waste Profiles S-010 for C/D Waste, Attachment 1.

B. Spoil material waste.

1. Remove spoil material and segregate from other wastes whenever possible.

2. Spoil materials are earthen clean/non-contaminated materials, typically other than special wastes, resulting from construction, and demolition of structures, and from road construction and repair including, but not limited to:

a. Gravel.
b. Soil.
c. Rock.
d. Concrete (no rebar)
e. Brick.
f. Cinder/Concrete blocks.
g. Clay products (tile, pipe, etc.).
h. Asphalt pavement.

3. Bulk handling and transport of spoil material wastes:

a. Size and load the waste into the waste delivery vehicles in such a manner to prevent the waste from becoming lodged in waste delivery vehicles and containers (i.e., dump truck beds, dump trailers, roll-off containers) during the dumping operations. The Seller shall be responsible for safely removing and clearing lodged materials from the waste delivery vehicles/containers and all associated costs.

b. Waste delivery vehicles shall not be leaking fluids.

c. It is recommended that wastes be delivered in vehicles that are self-dumping/unloading. If it is absolutely necessary to deliver bulky and containerized wastes on flatbed trucks or trailers, the waste generator shall minimize the generation of such containerized and bulky wastes and shall perform advance coordination with the Landfill Operations Manager for the unloading.

d. All containers intended for disposal must be greater than 90% full (less than 10% void) except for 55 gallon or smaller containers, which can be safely compacted with landfill equipment.

e. Refer to Master Waste Profiles S-050 (Attachment 2) for disposition of spoil material waste at the ORR landfill.

f. Specific instructions dealing with waste identification, transportation and logistics will be provided to subcontractor's field supervisor and truck drivers in a field briefing prior to start of work.

2.4 ORR LANDFILL INFORMATION

A. Disposal at the ORR landfill (formerly known as the Y-12 landfill) will be free of charge to the Seller according to the following schedule for non-hazardous, non-radiological demolition waste and construction debris generated at ORNL facilities.

B. Landfill hours of operation are subject to change monthly. An updated schedule will be made available to the Seller at the Company project kickoff meeting.

C. All personnel on the ground of any active ORR landfill must wear: high visibility apparel (i.e. highly reflective vests); safety glasses; safety shoes; and hard hats. Also, cell phone use is prohibited on the ORR landfill property.

D. The UCN-2109 forms approved by the ORR landfill Operations Office are the primary "ticket" to gain access to the ORR landfill. The Company will complete the required UCN-2109 form set for each waste stream intended for ORR landfill disposal, and initiate the review cycle required by the ORR Landfill Acceptance Manager.

E. The approved UCN-2109 forms will be available at ORNL Building 7014 Vehicle Portal Monitor (the inspection/monitoring station), and each load of waste intended for ORR landfill disposal must stop at Building 7014 for inspection, monitoring, and collection of forms before leaving ORNL.

F. Each load of waste delivered to the ORR landfill must be accompanied by a RADCON green tag. The Seller field supervision will be responsible for writing the correct UCN-2109 number on each green tag prior to the load leaving the project site. Copies of the approved UCN-2109's will be proved to the Seller at the field briefing prior to the start of work.

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Prohibited Items for Metal Recycle

- Acetylene cylinders
- Asbestos-containing material (i.e., insulated pipe and transite concrete fiber board)
- Leaking ballasts and PCB-containing equipment
- Fluorescent bulbs
- Fluid filled capacitors
- Closed compressed gas cylinders
- Closed containers of any kind
- Containers with free-flowing liquids inside or outside (e.g., tar, oil, gasoline)
- Flammable or combustible material/liquids or liquids of any type
- Rags/wipes containing solder paste and/or solvents
- Material or equipment containing refrigerants
- Munitions, bullets, military target range scrap, explosives
- Microwave ovens
- Paint cans
- Pressure regulated valves
- Radioactive material (including smoke detectors)
- Thermometers
- Thermostats
- Aerosol cans
- Barrels, drums, pails and buckets
- Gas tanks
- Propane cylinders
- Transformers (fluid filled or that have PCB's)
- Bio hazardous materials/fluids
- Batteries: NiCad, NiMH, Lithium ION, Alkaline
- Medical equipment that is not properly decontaminated (TCG can request a certificate of decontamination if unit appears to be soiled)
- Anything else that meets the definition of a characteristic (toxic, flammable, corrosive or reactive) or listed hazardous waste per Federal, State, or Local regulations. The only exceptions shall be materials that TCG is permitted to accept as detailed on our accepted materials list)

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Attachment 5: Prohibited Items for Metal Recycle

- Acetylene cylinders
- Asbestos-containing material (i.e., insulated pipe and transite concrete fiber board)
- Leaking ballasts and PCB-containing equipment
- Fluorescent bulbs
- Fluid filled capacitors
- Closed compressed gas cylinders
- Closed containers of any kind
- Containers with free-flowing liquids inside or outside (e.g., tar, oil, gasoline)
- Flammable or combustible material/liquids or liquids of any type
- Rags/wipes containing solder paste and/or solvents
- Material or equipment containing refrigerants
- Munitions, bullets, military target range scrap, explosives
- Microwave ovens
- Paint cans
- Pressure regulated valves
- Radioactive material (including smoke detectors)
- Thermometers
- Thermostats
- Aerosol cans
- Barrels, drums, pails and buckets
- Gas tanks
- Propane cylinders
- Transformers (fluid filled or that have PCB's)
- Bio hazardous materials/fluids
- Batteries: NiCad, NiMH, Lithium ION, Alkaline
- Medical equipment that is not properly decontaminated (TCG can request a certificate of decontamination if unit appears to be soiled)
- Anything else that meets the definition of a characteristic (toxic, flammable, corrosive or reactive) or listed hazardous waste per Federal, State, or Local regulations. The only exceptions shall be materials that TCG is permitted to accept as detailed on our accepted materials list)

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Attachment 5: Prohibited Items for Metal Recycle

- Acetylene cylinders
- Asbestos-containing material (i.e., insulated pipe and transite concrete fiber board)
- Leaking ballasts and PCB-containing equipment
- Fluorescent bulbs
- Fluid filled capacitors
- Closed compressed gas cylinders
- Closed containers of any kind
- Containers with free-flowing liquids inside or outside (e.g., tar, oil, gasoline)
- Flammable or combustible material/liquids or liquids of any type
- Rags/wipes containing solder paste and/or solvents
- Material or equipment containing refrigerants
- Munitions, bullets, military target range scrap, explosives
- Microwave ovens
- Paint cans
- Pressure regulated valves
- Radioactive material (including smoke detectors)
- Thermometers
- Thermostats
- Aerosol cans
- Barrels, drums, pails and buckets
- Gas tanks
- Propane cylinders
- Transformers (fluid filled or that have PCB's)
- Bio hazardous materials/fluids
- Batteries: NiCad, NiMH, Lithium ION, Alkaline
- Medical equipment that is not properly decontaminated (TCG can request a certificate of decontamination if unit appears to be soiled)
- Anything else that meets the definition of a characteristic (toxic, flammable, corrosive or reactive) or listed hazardous waste per Federal, State, or Local regulations. The only exceptions shall be materials that TCG is permitted to accept as detailed on our accepted materials list)

SECTION 01 77 00 - CLOSEOUT PROCEDURES

PART 1 - PROJECT REQUIREMENTS

1.1 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
   1. Substantial Completion procedures.
   2. Final completion procedures.
   3. Warranties.
   4. Final cleaning.

1.2 SUBSTANTIAL COMPLETION

A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete with request.
   1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
   2. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, facility manual and similar documents.
   3. Complete startup testing of systems.
   4. Submit test records.
   5. Terminate and remove temporary facilities from Project site, along with construction tools, and similar elements.
   6. Complete final cleaning requirements, including touchup painting.
   7. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
   8. Complete submittal log documenting closeout of submittals and resubmittals.

1.3 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for determining final completion, complete the following:
   1. Instruct Company's personnel in operation, adjustment, and maintenance of products, equipment, and systems, per Section 01 79 00.

1.4 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Seller that are outside the limits of construction.
   1. Include the following information at the top of each page:

a. Project name.
b. Date.
c. Name of Seller.
d. Page number.
2. Submit list of incomplete items in the following format:
a. PDF electronic file.

1.5 WARRANTIES

A. Submittal Time: Submit written warranties on request of Company for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.

B. Organize warranty documents into an orderly sequence based on the table of contents of the Facility Manual.

C. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - NOT USED

PART 3 - TECHNICAL REQUIREMENTS

3.1 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
b. Remove tools, construction equipment, machinery, and surplus material from Project site.
c. Leave Project clean and ready for occupancy.

B. Construction Waste Disposal: Comply with waste disposal requirements in Section 01 74 19, Demolition Waste Management and Disposal.

END OF SECTION 01 77 00

SECTION 01 78 23 - FACILITY SYSTEMS MANUAL

PART 1 - PROJECT REQUIREMENTS

1.1 SUMMARY

A. Section includes administrative and procedural requirements for preparing Facility Systems Manual, including the following:
   1. Operation manuals for systems, subsystems, and equipment.
   2. Highlighted equipment specification cutsheets indicating component supplied.
   3. Maintenance manuals for the care and maintenance of products, systems and equipment.
   4. Warranty Information

B. Related Sections:
   1. Section 01 33 00 Submittals for submitting copies of submittals for operation and maintenance manuals.
   2. Sections 01 91 33 Commissioning for verification and compilation of data into operation and maintenance manuals.
   3. Divisions 02 through 49 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

1.2 GENERAL

A. Organization: Each manual shall contain the following materials:
   1. Title page.
   2. Table of contents.
   3. Manual contents.

B. Title Page: Include the following information:
   1. Subject matter included in manual.
   2. Name and address of Project.
   3. Date of submittal.
   4. Name and contact information for Seller.
   5. Name and contact information for Company/Engineer.

C. Table of Contents: List each product included in manual identified by product name and cross-referenced to Specification Section number in Project Manual.
   1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

E. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.
   1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
      a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders, if necessary, to provide essential information for proper operation or maintenance of equipment or system.
      b. Identify each binder on front and spine, with printed title "FACILITY SYSTEMS MANUAL", Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
   2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
   3. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
      a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
      b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes.

F. Manuals, Electronic Copy: Submit manuals in searchable pdf format.

1.3 FACILITY SYSTEMS MANUAL

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
   1. Product name and model number. Use designations for products indicated on Contract Documents.
   2. Manufacturer's name.
   3. Vendor contact information including website if available.
   4. Nameplate data
   5. Equipment identification with serial number of each component.
   6. Performance curves.
   7. Engineering data and tests. Including test and balance (TAB) reports as required by subcontract documents.
   8. Operating procedures.
   9. Operating logs.
   10. Wiring diagrams.
   11. Control diagrams.
   12. Piped system diagrams.
   13. Precautions against improper use.
   14. License requirements including inspection and renewal dates.

B. For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information.

1. List of contacts for service and warranty issues for all equipment.
2. List and summary of warranties (including at minimum the scope of the warranty, term of warranty, and required preventive maintenance to maintain valid warranty).
3. Copies of specific written vendor warranties if required by contract (e.g., roof warranties).

C. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

1.4 SUBMITTALS

A. Maintenance Material Submittals
1. Preventative Maintenance
2. Spare Parts List
3. Operational Manuals

B. Closeout Submittal
1. Manual Submittal: Submit each manual in final form prior to Substantial Completion.
2. Correct or modify each manual to comply with Company’s comments. Submit copies of each corrected manual within 15 days of receipt of Company's comments.

PART 2 - NOT USED

PART 3 - TECHNICAL REQUIREMENTS

3.1 MANUAL PREPARATION

A. Operation Manuals: Assemble a complete set of operation data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.

B. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete/mark out references to information not applicable.

C. Comply with Section 01 77 00, Closeout Procedures for schedule for submitting operation and maintenance documentation.

END OF SECTION 01 78 23

SECTION 01 78 39 - PROJECT RECORD DOCUMENTS

PART 1 - PROJECT REQUIREMENTS

1.1 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:
   1. Record Drawings.
   2. Revised Calculations.
   3. Record Product Data.
   4. Miscellaneous record submittals.

B. Related Sections:
   1. Section 01 18 00 Site Utility Interface for Utility As-Built drawings
   2. Section 01 77 00 Closeout Procedures for general closeout procedures.
   3. Section 01 78 23 Facility System Manual for operation and maintenance manual requirements.
   4. Divisions 02 through 49 Sections for specific requirements for project record documents of the Work in those Sections.

1.2 RECORD DRAWINGS

A. Record Drawings: Maintain one full-sized set of marked-up paper copies of the Contract Drawings and Shop Drawings. The as constructed conditions shall be noted in red.
   1. Preparation: Mark prints to show the actual installation where installation varies from that shown originally.
      a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
      b. Accurately record information.
      c. Record data as soon as possible after obtaining it.
   2. Content: Types of items requiring marking include, but are not limited to, the following:
      a. Dimensional changes to Drawings.
      b. Revisions to details shown on Drawings.
      c. Locations and depths of underground utilities.
      d. Revisions to routing of piping and conduits.
      e. Revisions to electrical circuitry.
      f. Actual equipment locations.
      g. Changes made by Change Order and/or Requests for Information.
      h. Changes made following Company's written orders.
      i. Details not on the original Contract Drawings.
   3. Mark the Contract Drawings and Shop Drawings completely and accurately.
   4. Mark prints with erasable, red-colored pencil.
   5. Mark important additional information that was either shown preliminarily or omitted from original drawings.

6. Note Change Order and Request for Information numbers, and similar identification, where applicable.
7. Consolidate all mark-ups and incorporate information into Native (CAD) files as applicable.
8. Identify and date each revised Record Drawing; include the designation "RECORD DRAWING" in the revision block of revised Drawings.

B. Format:
1. Record Native (CAD) Files: Organize digital data information into separate electronic files that correspond to each revised sheet of the Contract Drawings.
2. Record Drawing Files: Generate electronic (PDF) drawing files from the Native (CAD) Files.

1.3 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

B. Format: Submit miscellaneous record submittals as paper copy and scanned PDF electronic file(s) of marked up miscellaneous record submittals.
1. Include miscellaneous record submittals directory organized by specification section number and title, electronically linked to each item of miscellaneous record submittals.

1.4 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:
1. Number of Copies: Submit copies of record Drawings as follows:
   a. Initial Submittal: Submit one paper copy or electronically scanned (PDF) set of marked-up prints and one set of Record Digital Data Files created from corrected Record Native (CAD) files within 30 days of Company acceptance. Company will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
   b. Final Submittal: Submit Record Drawing Files (PDF) and Record Native (CAD) Files within 30 days of Company acceptance of initial submittal.

PART 2 - NOT USED

PART 3 - NOT USED

END OF SECTION 01 78 39

SECTION 01 80 00 - DESIGN BUILD REQUIREMENTS

PART 1 - PROJECT REQUIREMENTS

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 DEFINITIONS

A. Delegated Design Services, A-E: An Architect-Engineering firm(s) that is currently licensed in the state of Tennessee and normally engages in architectural and engineering design work.

1.3 REFERENCE SECTIONS

A. Section 01 33 00 Submittals

1.4 SUBMITTALS

A. Design Reviews
   1. Reference Table 01 80 00-A, Design Document Review Submittal Schedule for limited summary of submittal information at each design phase.
   2. Submit as agreed upon during Predesign Conference.
   3. Schematic Design (30% design)
   4. Design Development (60% design)
   5. Construction Documents, pre-CFC (100% design)
   6. Certified for Construction, CFC, documents (Final)
      a. Design drawings:
         1) (1) Full size copy of design drawings
         2) Electronic file of Design drawings: In native format and bookmarked pdf.
      b. Construction specifications:
         1) (1) 8 ½ x 11 unbound hard copy of complete construction specifications.
         2) Electronic file of construction specification: In native format and searchable pdf with bookmarks.
      c. Electronic file of calculations: In native format and searchable pdf.
   7. Comment resolution from Design Development and Construction Document reviews, within 10 days of receipt of Company comments.

B. Listing of drawing titles for assignment of ORNL drawing numbers.

PART 2 - CODES AND STANDARDS

2.1 GENERAL

A. Work Smart Standards: Design and construction of the facility shall be in accordance with the 01 41 00 Work Smart Standards as applicable including deviations and other standards as listed in the body of this document.

PART 3 - PERFORMANCE REQUIREMENTS

3.1 PROJECT EXECUTION

A. Company: The Company will provide project, design and construction oversight.

B. Seller: The Seller shall provide professional services for complete design and construction of the project in accordance with the Design Build Performance Specification and Solicitation requirements.

C. Delegated Design: Engage a qualified professional engineer, A-E, as defined in Division 01 40 00 Section "Quality Requirements," to design all portions of this scope.
   1. Performance and Design Criteria: Provide products and systems complying with specific performance and project description, including this design criteria.

D. General
   1. Predesign Conference: Schedule and conduct a predesign conference in conjunction with the project kick-off meeting. The Predesign Conference shall be held before starting design, at a time convenient to Company, but no later than [**10**] business days after Notice to Proceed.
      a. Discussion shall include:
         1) Dates for design review submittals, including any partial submittal dates or early design packages.
         2) Dates for CFC document sign off(s) and a pre-construction conference.
         3) Prepare a discipline list of documents, similar to Table 01 80 00.1, with proposed levels of completion at each design review stage. The list will be reviewed and finalized at the meeting. List shall specify which submittal package the document will be issued under, if applicable.
         4) Representatives of the Seller, A-E firm and Company shall attend the meeting.
         5) This meeting does not replace the pre-construction conference.
   2. All construction documents, including drawings, specifications, and calculations shall be signed, dated and sealed by the responsible professional Engineer, Architect, Company or other licensed professional registered in the State of Tennessee. This applies to lead A-E firm and any A-E firms that are sub-tier to the lead firm.

3.2 CONTRACT DOCUMENTS

A. General
1. The minimum contract documents are listed in Table 01 80 50-A, Design Document Submittal Schedule. Other documents may be listed in the body of this design criteria.
2. Drawings, specifications, and calculations shall be sealed by the responsible Professional Engineer or Architect registered in the State of Tennessee.
3. Text documents shall be provided electronically in MS Word format, unless otherwise indicated, and shall include a table of contents.

B. Drawings
1. Design Drawings
   a. The Cover sheet shall list all project design drawings, reference drawings, and general notes. Include the drawing numbers, title, and revision number.
   b. Design drawings shall utilize the ORNL grid system. A minimum of two survey control points with their coordinate values and elevations shall be shown on the design drawings.
   c. Design coordinates and elevations shall be determined for utilities, roads, and parking areas at their principal points of definition. This information shall be provided on the design drawings.
      1) The principal points of definition for utility systems shall include utility poles, obstructions, manholes, valves boxes, and crossings with other systems.
      2) Principal points of definition for potable water and natural gas distribution systems shall be valve boxes, main line intersects, and fire hydrants.
   d. A-E shall design the tie-ins to the existing utility systems for installation by the Company. Seller shall furnish the excavation, materials and restoration.
   e. Engineering standards will be provided by the Company.
2. Drawings shall include all demolition plans, dimensional plans, elevations, sections, details, notes, and identification of materials and equipment necessary to complete construction of project.
3. CFC drawings shall be internally reviewed by all the A-E design disciplines to ensure that interfaces are correct, interferences do not exist, and overall coordination of design has taken place.
4. Drawing shall be produced using electronic software compatible with Bentley MicroStation format.
5. The minimum drawing scale, unless otherwise approved in writing by the Company, shall be:
   a. 1/8” = 1’-0” for plans.
   b. 1/4” = 1’-0” for building sections.
   c. 1/2” = 1’-0” for detail sections.
   d. 1” = 20’-0” for site plans.
6. ORNL grid system north shall be used. Indicate north to the top of the drawing sheet except where site conditions dictate otherwise.
7. Key Plans shall be provided on each sheet as appropriate.
8. Drawings shall be “E” size (34” x 44”) with standard Company title block (Company to provide electronic border file). Company will provide guidance on filling out title block to ensure compatibility with Company’s electronic storage system without modifications.
9. Drawing numbers will be provided by the Company.
10. Electronic master seed file provided by the Company.

11. Computer Aided Drafting (CAD) files shall be generated in accordance with Company CAD Manual (FDD-DM-330).

C. Control Points and As-built Requirements
   1. Design drawings shall utilize the ORNL grid system. A minimum of two survey control points with their coordinate values and elevations shall be shown on the design drawings.
   2. Design coordinates and elevations shall be determined for utilities, roads, and parking areas at their principal points of definition. This information shall be provided on the design drawings.
      a. The principal points of definition for utility systems shall include utility poles, obstructions, manholes, valves boxes, and crossings with other systems.
      b. Principal points of definition for potable water and natural gas distribution systems shall be valve boxes, main line intersects, and fire hydrants.
   3. Design documents shall require the Seller (contractor) to maintain red line as-built drawings during the construction and submit upon completion of project.
      a. Seller shall submit as-built coordinates and elevations of the underground utilities as soon as they are available.
      b. Electronic Record drawings will be created from the red line as-built drawings by the Seller's AE.
         1) Record drawings shall be in Microstation or Autocad (file extension .dgn or .dwg) format.
         2) Record drawings provided by the Seller shall be stamped by the registered professional engineer or architect.

D. Construction Specification
   1. Each Division's index sheet shall be sealed by the responsible Professional Engineer or Architect registered in the State of Tennessee.
   2. Divisions 02 through Division 46 shall be provided utilizing the Construction Specification Institute current version format.
   3. Division 01 shall be used as provided by the Company.
   4. Schematic Design (30%) submittal shall only include the index of proposed Construction Specification Sections.
   5. Design Development (60%) submittal shall be an edited version of the Construction Specification with all edits highlighted using MS Work Track Changes or similar.
   6. Construction Documents 100% submittal shall have all 60% comments incorporated and 60% highlights removed. The 100% submittal shall have all of the edits made from 30% to 60% identified. The 100% submittal shall be considered a complete set of Contract Documents ready for final signatures to be submitted as CFCs. It is intended that the only remaining item to complete is final signatures to allow issue of CFCs. Documents

E. Calculations
   1. Design calculations shall clearly document the design decisions, assumptions, and basis for design (codes, standards, design loads, design factors).
   2. A qualified reviewer (i.e., checker) capable of generating the calculation himself/herself shall check and sign the CFC calculations for accuracy and concurrence with design assumptions and philosophy.
   3. An independent peer review of the seismic design will also be required.
   4. Calculations shall be sealed by the responsible Professional Engineer or Architect registered in the State of Tennessee.
   5. Calculations shall be provided in hard copy and electronically in PDF format.

F. Basis of Design.
1. Prepare a Basis of Design (BOD) document defining the programmatic detail to describe systems, subsystems and major components, identify relevant codes and standards. The BOD shall contain one-line diagrams, floor loadings, room data sheets, and system descriptions at a minimum.
2. The BOD shall be organized using the Uniformat II per ASTM Uniformat II E1557 in MS Word format at 30% and 100% review and shall include a table of contents.

G. Government Furnished Equipment (GFE)
1. GFE includes equipment and installation unless noted otherwise. GFE includes furniture and cubicle walls, metal laboratory casework, appliances that are not installed in the casework or in the wall, telephones, computers and associated hardware, and equipment as noted. GFE does not include millwork (built in case goods, wood or metal).

H. Specialty Consultants
1. Site Acoustical/Vibration Specialty Consultant
2. Electromagnetic Interference (EMI) Specialty Consultant

I. Commissioning Plan
1. A project specific Cx plan will be developed by the Company's Building Commissioning Agent (BCA) and incorporated into the project documents and scope of work.
2. Seller shall participate in project commissioning activities as outlined in the Cx Plan and as specified in the Contract Documents.

3.3 DESIGN REVIEW

A. Formal design reviews with the Company shall be held at the following or as approved by the Company:
1. Schematic Design (30% design)
2. Design Development (60% design).
3. Construction Documents, pre-CFC (100% design)

B. Company will return comments to A-E within 15 days of receipt of submittal packages.

C. The A-E shall provide formal written responses to the Company's design review comments 10 business days after receipt of Company comments. Comment log should include comment, date and response at a minimum.

D. All design reviews shall be held at ORNL unless otherwise agreed by the Company. All disciplines shall attend the design reviews.

E. ORNL's acceptance of the CFCs (Contract Documents) in no way relieves the Seller of compliance with the Design Criteria.

F. A-E Activities during Construction Phase
1. A-E to perform weekly field observation to verify construction work is in accordance with final design documents. With Company approval, the frequency of field observation
2. visits may be reduced or increased based on level or type of construction activity. A-E shall provide documentation in the form of a field observation report for each site visit.

3. After each job site visit during construction, provide a progress and surveillance report. Briefly summarize activities occurring during the reporting interval including material deliveries, work progress, testing and engineering changes.
4. Review and approve submittals such as vendor and manufacturer data, concrete design mixes, and shop drawings before submittal to the Company. Indicate the A-E review was performed by signing the submittal cover sheet.
5. Perform off-site inspection and witnessing of tests at location of production, manufacture, or shipment to ensure a quality product. Off-site inspection and witnessing of tests shall be performed as instructed by the Seller.
6. Provide oversight, document, and certify Seller required tests.
7. Participate in punch list identification, start-up activities, commissioning and final inspections.
8. Maintain field records for purposes of A-E providing Record Documents.

G. Final Acceptance
1. Upon project completion, A-E to submit a letter of certification that work has been completed in accordance with the Contract Documents.

Table 01 80 00-A Design Document Submittal Schedule				
DISCIPLINE	REVIEW			
	30%	60%	100%	CFC
1. MULTI-DISCIPLINE:				
Demolition Plans	X		X	X
Demolition Specifications		X	X	X
Cost Estimate	X	X	X	X
Guiding Principles for Sustainable Federal Buildings Checklist for New Construction and Modernization	X	X	X	X
Energy Star Computer Generated Benchmark Score				
Energy Analysis – All Computer Generated Output (i.e. printouts)	X			X
Life Cycle Cost Analysis Documentation – BLCC Computer Output. Including input and output electronic files.	X			X
Energy Efficiency and Sustainability Report			X	X
Value Engineering Study	X			
ASHRAE 90.1-2013 Compliance Documentation	X			X
Excavation/Penetration Permit		X	X	X
Formal written responses to design review comments	X	X	X	X
Construction Specification – Provide index only at 30%	X	X	X	X
Design Basis Document	X		X	X
2. CIVIL:				
Site Access Plan - Index drawing & notes		X	X	X
Geotechnical Report (if required)	X			X
Access Road Improvements & Additions Plans and Details	X	X	X	X
Site utilities Plan, profile, and details	X	X	X	X
Site Grading Plan	X	X	X	X
Site Survey (by Seller)	X			
Site Layout Plan	X	X	X	X
Storm Drain – Plans, profile and details and Profiles	X	X	X	X
Calculations (including 500 yr hydrologic evaluation)	X	X	X	X
Project Specific SWPPP		X	X	X
3. STRUCTURAL:				
Framing - Plans & Elevations	X	X	X	X
Framing - Sections and details		X	X	X
Foundations – Plans	X	X	X	X
Foundations - Sections and details		X	X	X
Miscellaneous - Plans, sections and details		X	X	X
Calculations	X	X	X	X
4. ARCHITECTURAL:				
Floor Plans	X	X	X	X
Roof Plan		X	X	X
Exterior Elevations	X	X	X	X

Table 01 80 00-A Design Document Submittal Schedule				
DISCIPLINE	REVIEW			
	30%	60%	100%	CFC
Building Sections	X	X	X	X
Wall Sections	X	X	X	X
Partial Plans	X	X	X	X
Enlarged Plans				
Reflected Ceiling Plan		X	X	X
Miscellaneous Schedules (Door, Room Finish, etc.)		X	X	X
Interior Details			X	X
Exterior Details		X	X	X
Site Acoustical/Vibration and EMI mitigation recommendations	X			
Site Acoustical/Vibration and EMI mitigation details		X	X	X
Miscellaneous Plans and Details		X	X	X
Calculations		X	X	X
5. MECHANICAL – HVAC:				
Plans	X	X	X	X
Elevations, Sections and Details		X	X	X
Equipment Schedules	X	X	X	X
Controls Diagrams/P&ID’s/Sequence of Operations	X	X	X	X
Calculations	X	X	X	X
See MULTI-DISCIPLINE items for additional requirements.	X	X	X	X
6. MECHANICAL - PIPING:				
Building Systems Plans	X	X	X	X
Site Utility Systems Plans & Details	X	X	X	X
Isometrics		X	X	X
Systems Details		X	X	X
Schedules	X	X	X	X
Spreadsheet of Backflow Preventers and Building Drain Locations				X
Control diagrams/P&IDs/Sequence of Operations	X	X	X	X
Calculations		X	X	X
Equipment Specifications		X	X	X
7. FIRE PROTECTION:				
Code Footprint	X	X	X	X
Fire Protection Systems	X	X	X	X
Fire Alarm Plan		X	X	X
Fire Alarm Wiring and Riser Diagrams		X	X	X
Compliance Review	X	X	X	X
8. ELECTRICAL:				
Electrical Site Plan, Legend, and Notes	X	X	X	X

Table 01 80 00-A Design Document Submittal Schedule				
DISCIPLINE	REVIEW			
	30%	60%	100%	CFC
One Line Diagram	X	X	X	X
Panel Schedules		X	X	X
Building Power and Receptacle Plan		X	X	X
Grounding Plan		X	X	X
Duct Bank Details		X	X	X
Conduit and Cable Schedules		X	X	X
Schematics, Interconnection, and Wiring Diagrams		X	X	X
Miscellaneous Details, Sections, and Elevations		X	X	X
PLC Interconnection Wiring Diagram		X	X	X
Instrument Loop Diagrams		X	X	X
Process & Instrument Diagram		X	X	X
9. COMMUNICATION				
Communication Plan		X	X	X
10. SECURITY				
Security Plan		X	X	X
11. LANDSCAPE:				
Landscape Plan		X	X	X
Landscape Details and Plant list		X	X	X
12. COMMISSIONING (Cx)				
Cx Related Specifications (within const. spec sections)		X	X	X

END OF SECTION 01 80 00

SECTION 01 81 13 – ENERGY AND SUSTAINABILITY

PART 1 - PROJECT REQUIREMENTS

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.

1.2 SUMMARY

A. Energy – Due to the nature of the AML Addition as a state-of-the-art microscopy facility, the primary design goal is to meet the performance requirements. Energy conserving design practices shall be used to the extent allowed by the environmental control tolerances required to support instrument operation and the AML facility. Since environmental stability (temperature, humidity, and pressure) is of paramount importance, economizer control (free cooling), temperature set back, etc., shall not be used since use of these measures will create abrupt changes within the building. The AML Addition will be inherently energy efficient due to low lighting levels and the thermally efficient building envelope.

B. Sustainability.
   1. The project will follow the 2020 Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings requirements.
      a. The Architect-Engineer (A-E) shall provide a LEED Accredited Professional to coordinate and lead the project design team’s sustainability effort to cost effectively achieve the Guiding Principles, including all the required design documentation.
      b. The A-E shall provide construction specifications that clearly identify Guiding Principle submittal requirements.

PART 2 - CODES AND STANDARDS

2.1 DESIGN STANDARDS

A. Work Smart Standards referenced in Section 01 41 00 apply to this Section.

PART 3 - TECHNICAL REQUIREMENTS

3.1 GENERAL REQUIREMENTS

A. The sustainable building design process shall be applied to the site, design and construction phases of the project to evaluate applicable renewable energy usage, water and energy conservation features.
   1. The design shall specify construction products that contain the Environmental Protection Agency's (EPA's) recommended recovered materials outlined in 40 CFR 247, if they meet the performance requirements of the project and are life-cycle cost effective. See http://www.epa.gov/epaoswer/non-hw/procure/products.htm for the required percent of recycled material. These items have been specifically identified in the body of this document in the specific discipline sections.
   2. The construction contractor will be required to report the total costs of each of these materials on a project. This will be covered in Division 1 documents.

B. The facility must be certified to a level that promotes the high performance sustainable building guidelines per the DOE Order 436.1 and as referenced in Executive Order 13834 "Efficient Federal Operations" issued May, 2018.

3.2 VALUE ENGINEERING (VE)

A. The A-E shall provide VE techniques and cost-effective evaluations of various sustainable design features pursued.

B. The A-E shall perform a VE study and submit a report to the Company for review at least two weeks prior to the scheduled 30% design review date.

C. The A-E shall provide a certified VE professional to facilitate the VE study.

3.3 LIFE CYCLE COST ANALYSIS (LCCA)

A. Life-cycle cost analysis shall be performed by the A-E in accordance with 10 CFR 436, Subpart A.

B. The LCCA documentation shall be provided with output from the latest version of the NIST "Building Life-Cycle Cost" Program. Input to the BLCC program shall be as described in the software user's guide and reference manual.
   1. Visit the DOE Federal Energy Management Program (DOE-FEMP) website http://www1.eere.energy.gov/femp/information/download_blcc.html to obtain a copy of the BLCC program with user's guide and reference manual and other analytical software tools.

3.4 ENERGY EFFICIENCY

A. Compliance with ASHRAE Standard 90.1-2013 shall be documented by the A-E by demonstration of Energy Cost Budget Method of compliance per Section 11.

B. Compliance with 10 CFR 433 shall be accomplished by meeting the baseline energy efficiency requirements of ASHRAE 90.1-2013 at a minimum and at least 30% more energy efficient when life cycle cost effective.

C. Energy Star.
1. The A-E shall specify Energy Star labeled products when proved cost effect in a LCCA.
2. To receive the Energy Star label for a facility in accordance with the EPA's Energy Star labeling procedure, the office portion shall be designed and operated to achieve a benchmark score of 75 or higher.
   a. For more information see Energy Star web site.
   b. Energy Star label only applies to office building or office portion of a facility.
   c. The A-E shall include metering for the office related energy consumption to determine the actual Energy Star rating.

3.5 ENERGY EFFICIENTY AND SUSTAINABILITY REPORT

A. The A-E shall generate an Energy Efficiency and Sustainability Report to highlight project specific energy efficiency features and document compliance with the 2013 edition of the ASHRAE 90.1 energy efficiency standard.

END OF SECTION 01 81 13

Council on Environmental Quality

Guiding Principles for Sustainable Federal Buildings

And Associated Instructions

December 2020

CEQ-OFS-2020-1

Contents

I. Purpose

Since 2002, the Federal Government has outlined its intent to advance sustainable building principles and practices throughout its portfolio established through a number of statutory and executive policies that every Federal agency has integrated and utilized. These sustainable principles and practices have been incorporated into six Guiding Principles for sustainable Federal buildings (Guiding Principles), outlined below, to guide agencies in designing, locating, constructing, maintaining, and operating Federal buildings in a sustainable manner that increases efficiency, optimizes performance, eliminates unnecessary use of resources, ensures the health of occupants, protects the environment, generates cost savings, and mitigates risks to assets, consistent with Agency and Department missions.

Congress has enacted a range of statutory provisions relating to high-performance sustainable buildings, as well as energy and environmental goals and requirements that are advanced by the implementation of sustainable Federal buildings within an agency's portfolio.[1] Federal agencies must meet statutory requirements regarding high-performance sustainable buildings. The *Guiding Principles for Sustainable Federal Buildings and Associated Instructions* (Guidance) provide agencies with a means to meet these requirements as well as Executive Order (E.O.) 13834, *Efficient Federal Operations* (May 17, 2018) and the *Implementing Instructions for Executive Order 13834* (April 2019) (E.O. 13834 Implementing Instructions). The six Guiding Principles align with the definition of a high-performance green building established in the Energy Independence and Security Act (EISA) of 2007 (42 U.S.C. § 17061(13)), and serve as guidelines for Federal agencies to assess progress towards the sustainability metrics associated with their real property assets, in accordance with the statutory duties of executive agencies (40 U.S.C. § 524).

Consistent with section 3(a) and (d) of E.O. 13834 and the E.O. 13834 Implementing Instructions, this 2020 update of the *Guiding Principles for Sustainable Federal Buildings and Associated Instructions* (Guidance) consolidates, into one comprehensive set, the six Guiding Principles and improves their usability and consistency while not changing policy regarding sustainable Federal buildings. This version replaces and supersedes the previous version of the Guidance issued in February 2016, along with the *Guidance for Federal Agencies on Sustainable Practices for Designed Landscapes* (October 2011) and the *Implementing Instructions-Sustainable Locations for Federal Facilities* (September 2011).

The six Guiding Principles for sustainable Federal buildings incorporated into this Guidance were developed based on fundamental sustainable design practices and reflect progress in building design, construction, and operation best practices as well as ensuring efficient operations; protecting occupant health, wellness, and productivity; and promoting resilient buildings. The Guiding Principles ensure Federal buildings:

1. Employ Integrated Design Principles
2. Optimize Energy Performance
3. Protect and Conserve Water
4. Enhance the Indoor Environment

[1] *See, e.g.*, 42 U.S.C. § 17092: High-performance green Federal buildings; 42 U.S.C. § 17093: Federal Green Building Performance; 42 U.S.C. § 17144: OMB Government efficiency reports and scorecards; 42 U.S.C. 17061(13): Definition of high-performance green building; and 42 U.S.C. § 17061(12): Definition of high-performance building. Additional specific authorities are referenced throughout Appendices A through E.

5. Reduce the Environmental Impact of Materials
6. Assess and Consider Building Resilience

To ensure consistency, transparency, and accountability regarding sustainable Federal buildings, the E.O. 13834 Implementing Instructions provide direction on how agencies can demonstrate the implementation of sustainable design building initiatives to the Office of Management and Budget (OMB) (42 U.S.C § 17093 and 42 U.S.C § 17144).

The improvements made through this update address specific questions from agencies on the previous version of this Guidance, and provide additional clarity on technical applications and requirements as well as increased flexibility that recognizes the diversity of building functions and agency missions. This update simplifies multiple guidance documents to avoid confusion and inconsistent implementation. Additional direction and clarification on the use of third-party building certification systems and their relative equivalence to the Guiding Principles is also provided.

To address ambiguity under the prior version of this Guidance that exists in situations where the application life cycle cost-effectiveness or where a building's inherent function, mission, safety, or designation prevents the building from meeting the requisite criteria in order to be designated a sustainable Federal building, this update clarifies that those buildings that demonstrate a level of improved performance and sustainability, but do not meet the requisite criteria, may be designated as Federal high-performance buildings, in alignment with the statutory definition (42 U.S.C § 17061(12)).

As a result, this Guidance provides a streamlined practical, common sense approach to address frequently asked questions by agencies, reduce burden and costs, and increase flexibility by recognizing improved building performance.

The implementation of this Guidance can help ensure a consistent government-wide portfolio approach for Federal agencies to design, mitigate, and measure the impact of their buildings. This Guidance also provides agencies with a resource for long-term risk management and mitigation, to ensure agency portfolios remain effective and operational for the life of their facilities.

Instructions

The Guiding Principles, described in Section II of this Guidance, are sustainable design and operational principles that agencies can implement in both new and existing Federal buildings by following either the checklists in Appendices A and B or the third-party systems in Appendix C. These two pathways provide agencies with options to qualify a building as a sustainable Federal building consistent with the EO 13834 Implementing Instructions. The Appendices detail how to assess whether a new or existing building meets the Guiding Principles using the different assessment pathways, the reassessment process, and reporting requirements.

References for relevant statutory, regulatory, and industry standards are included in the criteria checklists provided in the appendices.

Appendix A Assessing a Building Using the *Guiding Principles for Sustainable Federal Buildings Criteria Checklist for New Construction and Modernization*	Directions on assessing new construction and modernization buildings using the Federal criteria checklist.
Appendix B Assessing a Building Using the *Guiding Principles for Sustainable Federal Buildings Criteria Checklist for Existing Buildings*	Directions on assessing existing buildings using the Federal criteria checklist.
Appendix C Assessing a New Construction, Modernization, Major Renovation or Existing Building Using Third-Party Building Certification Systems	Directions on assessing new construction and modernizations, and major renovations or existing buildings using approved third-party building certification systems.
Appendix D Assessing a Building Using the *Guiding Principles for Sustainable Federal Buildings Reassessment Criteria Checklist*	Directions on reassessing buildings to determine whether they continue to meet high-performance or sustainable Federal building criteria.
Appendix E Sustainable Federal Buildings Reporting Instructions	Instructions on tracking and reporting of sustainable Federal buildings.
Appendix F Definitions	Relevant definitions from statute and key building terms.

II. Guiding Principles for Sustainable Federal Buildings

1. Employ Integrated Design Principles

1.1. Integrated Design and Management

Use a collaborative and integrated process to plan, design, construct, commission, and transition to operation each new building or modernization project. Consider design choices and operational components that improve environmental performance. Consider all stages of the building's life cycle when designing for all elements related to the Guiding Principles criteria. For existing buildings, apply integrated management principles to assess current and planned operating conditions to identify areas for optimization. Agencies should ensure plans include provisions or the ability to accommodate temporary changes to normal operating conditions due to emergencies or significant events.

1.2. Sustainable Siting

Follow an integrated site development process to conduct a site assessment that considers environmental, economic, and mission impacts and works to inform decisions on site design, construction, operations, and maintenance. Identify and mitigate current and projected site specific long-term risks through considerations that provide resilience to manmade and natural events such as hurricanes, storm surge, drought, flood, wind, and wildfire risks. Consider potential significant impacts to ensure the protection of historic properties and other cultural resources. Use historic properties available to the agency, to the maximum extent feasible, as designated by statute. Agencies should seek to find the right balance among sustainability, cost, and security considerations.

1.3. Stormwater Management

Meet statutory requirements for new construction, modernizations, and renovations, and employ strategies that reduce stormwater runoff and discharges of polluted water offsite to protect the natural hydrology and watershed health. Where feasible, use low impact development (LID) strategies to maintain or restore the natural, pre-developed ability of a site to manage rainfall.

1.4. Infrastructure Utilization and Optimization

Seek location-efficient sites, prioritizing locations that promote robust transportation choices, align with local and regional planning goals, and maximize the use of existing resources. Evaluate and provide appropriate electric vehicle charging infrastructure, consistent with current and anticipated future agency mission needs, when designing or renovating associated infrastructure, in accordance with applicable statutes, regulations, local laws, and agency policies.

1.5. Commissioning

Employ the appropriate commissioning tailored to the size and complexity of the building type and its system components to optimize and verify performance of building systems. Ensure buildings have operational policies that support continued compliance with all relevant statutory requirements for ongoing energy and water audits, where applicable.

2. Optimize Energy Performance

2.1. Energy Efficiency

Comply with all relevant statutory and regulatory requirements that establish Federal building energy efficiency standards and require the purchase, installation, and use of energy efficient products and/or equipment. Employ strategies that continue to optimize energy performance and minimize energy use throughout the operation and life of the building.

2.2. Energy Metering

Install building level meters for electricity, natural gas, and steam in order to track and continuously optimize energy performance. As required by statute, install advanced meters to the maximum extent practicable. Standard meters should be used when advanced meters are not appropriate.

2.3. Renewable Energy

Employ strategies to develop and integrate the use of life cycle cost-effective renewable electric energy and thermal renewable energy, in alignment with agency priorities to support applicable renewable energy goals.

2.4. Benchmarking

Benchmark building performance at least annually. Regularly monitor building energy performance against historic performance data and peer buildings to identify operating inefficiencies and conservation opportunities.

3. Protect and Conserve Water

3.1. Indoor Water Use

Minimize the use and waste of indoor potable water, and in accordance with statute, implement water conservation technologies to the maximum extent that the technologies are life cycle cost-effective. Purchase water conserving products and ensure optimized indoor water operations to the maximum extent practicable.

3.2. Water Metering

Install building level water meters in order to track and continuously optimize indoor potable water use, including detection of leaks.

3.3. Outdoor Water Use

Utilize current best practices and management strategies for water efficient landscaping, and employ, to the maximum extent practicable, water efficient irrigation strategies to track and reduce outdoor potable water consumption. Use non-irrigated, drought-tolerant native landscaping where practicable.

3.4. Alternative Water

Maximize the use of alternative sources of water to the extent practicable and where permitted under local laws and regulations.

4. Enhance the Indoor Environment

4.1. Ventilation and Thermal Comfort

Comply with all relevant statutory requirements to provide occupants with safe and healthy ventilation and thermal comfort, in alignment with applicable ASHRAE standards.

4.2. Daylighting and Lighting Controls

Maximize opportunities for and benefits of daylighting in regularly occupied space to introduce daylight and views into the spaces, except where not appropriate because of building function, mission, or structural constraints; reinforce circadian rhythms; and reduce the use of electrical lighting. Ensure appropriate lighting controls and task lighting.

4.3. Low-Emitting Materials and Products

Purchase, acquire, and ensure the use or application of low-emitting materials and products during the planning, construction, modification, maintenance, and operations of the facility.

4.4. Radon Mitigation

Ensure compliance with statutory and regulatory requirements to test for and mitigate radon in buildings, where appropriate.

4.5. Moisture and Mold Control

Implement moisture control strategies to minimize mold growth and associated health risks during building operations.

4.6. Indoor Air Quality during Construction and Operations

Implement necessary policies and protocols to prevent moisture damage to building materials and protect indoor air quality during renovations, repairs, and construction. Ensure indoor air quality procedures are in place that protect the air quality for occupants of the building during operations.

4.7. Environmental Smoking Control

Prohibit smoking in any form within the building and near all building entrances, operable windows, and building ventilation intakes, as specified by statute and regulations.

4.8. Integrated Pest Management

Implement and maintain a plan to encourage an environmentally responsible, integrated pest management approach that emphasizes proactive solutions, minimizes pesticide use, and, where chemical pesticides are needed, uses the least-toxic options.

4.9. Occupant Health and Wellness

Design building features and integrate programs and initiatives that promote voluntary physical health and wellness opportunities for the building occupants.

5. Reduce the Environmental Impact of Materials

5.1. Materials - Recycled Content

Use products that meet or exceed the Environmental Protection Agency's (EPA's) recycled content recommendations for building construction, modifications, operations, and maintenance, where applicable and as required by statute.

5.2. Materials - Biobased Content

Use products with the highest content level per the U.S. Department of Agriculture's (USDA's) bio-based content recommendations, where applicable and as required by statute.

5.3. Products

Procure and utilize construction materials and building supplies that have a lesser or reduced effect on human health and the environment over their life cycle when compared with competing products that serve the same purpose.

5.4. Ozone Depleting Substances

Comply with all relevant statutory requirements and regulations that identify substitutes for ozone-depleting substances.

5.5. Hazardous Waste

Ensure compliance during construction and operations with all relevant statutory requirements for hazardous waste management, including generation, storage, transport, and releases of hazardous substances.

5.6. Solid Waste Management

Reduce waste disposed of in landfills and incineration facilities by recovering, reusing, and recycling materials. Provide in building design, construction, renovation, and operation for the collection and storage of recyclable materials, including, as appropriate, compostable materials. Maintain a waste reduction and recycling program, and maximize waste diversion to the extent practicable. Pursue cost-effective waste minimization during the construction and renovation phase of the building, and maximize reuse or recycling of building materials, products, and supplies.

6. Assess and Consider Building Resilience

6.1 Risk Assessment

Determine the long-term mission criticality of the building and the operations to be housed in the building. Identify and assess both potential current and future regional risks to ensure resilient building design and operations and reduce potential vulnerabilities. Where applicable, align assessment and planning activities with local and regional efforts to increase community resilience.

6.2 Building Resilience and Adaptation

Incorporate resilient design and operational adaptation strategies that reduce the risk to and increase the resilience of the building. Avoid or mitigate the short- and long-term adverse impacts associated with projected climate changes and acute weather events, including storms, wildfires, droughts, and floods. To protect and ensure investments in Federal facilities, balance options to address current and projected risks against mission criticality, cost, and security needs over the building's intended service life.

III. Meeting the Guiding Principles

Applicability

Agencies should apply this Guidance on an individual building basis. Agencies are encouraged to consider the project scope and purpose of the building as well as mission needs to determine which assessment pathway set forth below to use.

Agencies also can and should utilize portfolio-wide sustainable policies and practices, where applicable, to meet relevant criteria, supporting a consistent and uniform approach to sustainable Federal buildings across their portfolios. Additional details on the use of campus-wide or installation-wide approaches are provided in Appendices A and B.

Assessment Pathways

As set forth in the E.O. 13834 Implementing Instructions Section III.A.5, "agencies may qualify sustainable Federal buildings, including existing buildings, new construction, and major renovations, using one of the following:"

1. The Guiding Principles for Sustainable Federal Buildings and Associated Instructions (Criteria Checklists, outlined in Appendix A and B), or
2. Third-party building certification systems or standards identified by the U.S. General Services Administration's (GSA's) Office of High-Performance Buildings (outlined in Appendix C).

For new construction, modernizations, and major renovations projects, GSA's recommendations are based on the criteria identified in 10 CFR § 433.300 or 10 CFR § 435.300, as applicable. A choice of assessment pathways provides agencies with flexibility to utilize whichever system can best support and align sustainable elements to their unique building and project needs. Agencies can continue to develop or utilize any available resources or tools, including those which assist in the assessments, to ensure that the building meets the criteria in Appendices A, B, or D.

Regardless of the pathway used, agencies must ensure that all building-level statutory requirements are met.

Operational Impacts

This Guidance also supports some functions inherent in building utilization, including optimizing operation and maintenance, which should be continued throughout the operational life of the building. Reassessment of building operations and performance every four years aligns with the EISA 2007 (42 U.S.C. 8253(f)(3)(A)) requirement for building evaluations and ensures the planned savings and impacts of sustainable Federal buildings continue to be realized.

Life Cycle Cost-effectiveness

Agencies should apply all criteria within this Guidance where determined to be life cycle cost-effective and in alignment with agency mission and budget, and building or project scope. Certain statutory mandates reiterated through the Guiding Principles criteria also have requirements for life cycle cost-effectiveness. The term "cost-effectiveness" should include the use of benefit-cost analysis in accordance with OMB Circular, A-11, Capital Programming Guide, 10 CFR Part 436, Subpart A, and National Institute of Standards and Technology (NIST) and Federal Energy Management Program (FEMP) *"Life Cycle Costing Manual for the Federal Energy Management Program"* Handbook 135.

Considerations for Building Mission and Unique Functions

To ensure consistency and transparency, if an agency determines that the building's inherent function, mission, safety, or designation prevents it from meeting the minimum threshold of requisite criteria for a sustainable Federal building in a life cycle cost-effective manner as outlined in Appendices A and B or the minimum certification level in Appendix C, the building would not qualify as a sustainable Federal building under this Guidance. For the purposes of supporting the policy outlined in this Guidance, these buildings may subsequently be designated as Federal high-performance buildings (42 U.S.C § 17061(12)), so long as they have met as many required criteria for the building type that are determined to be life cycle cost-effective.

Effective Date

All projects can utilize this version of the Guidance immediately upon issuance. However, in instances where an agency has already taken significant action and a change of reference could incur significant costs or result in project delays, an agency may continue to utilize the 2016 Guidance for that project. For the purposes of such a determination in relation to this Guidance, significant action means, for new constructions projects, the project budget has been appropriated, or for existing buildings, the agency has already made substantial progress in assessing the building. If the relevant threshold above is met within 180 days of issuance of this guidance, the agency may continue using the criteria in the 2016 Guidance to assess and qualify the building.

Buildings and projects assessed under a prior version of the Guidance may be considered grandfathered, and can continue to be reported as meeting the Guiding Principles so long as those buildings continue to meet the reassessment requirements established in the 2016 Guidance and outlined in Appendix D. A grandfathered building should be reassessed four years from the fiscal year it was last assessed as meeting the 2016 Guiding Principles or, if grandfathered prior to 2016, no later than four fiscal years from the issuance of this Guidance.

Accountability

Each agency is responsible for evaluating and determining, on an individual building basis, whether its buildings meet the Guiding Principles as outlined in this Guidance. Agencies should utilize the instructions and resources provided in the Appendices to assist with their determination and documentation. It remains at the discretion of the agency to establish and maintain all processes for appropriately documenting the assessment of their buildings, whether conducted internally or using external resources. Agencies should maintain appropriate records of each building assessment to support determinations and sustainability designation of their buildings.

IV. General Provisions

To accommodate future updates in technologies, industry standards, third-party certification systems and methodologies of integrating sustainability, CEQ reserves the ability to update the technical criteria in the appendices of this Guidance in the future to add additional options or pathways that could support a building in meeting the Guiding Principles.

Agencies must implement this Guidance consistent with applicable law and regulations, and subject to the availability of appropriations or other authorized funding. This Guidance does not supersede or invalidate any existing laws, regulations, or other legal requirements. If there is a conflict between the Guidance and a statute or regulation, then the statute or regulation governs. The contents of this Guidance do not have the force and effect of law and are not meant to bind the public in any way. This document is intended solely to improve the internal management of the Executive Branch. It is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable by any party against the United States, its departments, agencies, or entities, its officers, employees, or agents, or any other person.

APPENDICES

Appendix A - Assessing a Building Using the Guiding Principles for Sustainable Federal Buildings Criteria Checklist for New Construction and Modernization

Appendix B - Assessing a Building Using the Guiding Principles for Sustainable Federal Buildings Criteria Checklist for Existing Buildings

Appendix C - Assessing a New Construction, Modernization, Major Renovation or Existing Building Using Third-Party Building Certification Systems

Appendix D - Assessing a Building Using the Guiding Principles for Sustainable Federal Buildings Reassessment Criteria Checklist

Appendix E - Sustainable Federal Buildings Reporting Instructions

Appendix F - Definitions

Appendix A

Assessing a Building Using the
Guiding Principles for Sustainable Federal Buildings Criteria Checklist for

New Construction and Modernization (NC&M)

This Guiding Principles for Sustainable Federal Buildings Criteria Checklist is a tool that agencies may use to demonstrate that a **new construction or modernization project** meets the intent of the Guiding Principles. Criteria on the checklist include both design elements and operational procedures that can be used to demonstrate continued operation as a sustainable Federal building after construction.

Instructions for NC&M:

The New Construction and Modernization checklist contains 30 criteria for agencies to assess in order to demonstrate that the building meets the policy outlined in this Guidance. All criteria should be considered as part of the initial assessment process and throughout the design and construction of the project.

> **Core Criteria:** Eighteen core criteria, supported by statutory and regulatory requirements and green building industry standards, are considered fundamental principles for any Federal high-performance green building (42 U.S.C. § 17061(13)). **To qualify as a sustainable Federal building under this Guidance the building must meet all 18 of the core criteria.**
>
> **Non-Core Criteria:** For the remaining 12 criteria that are not indicated as core, agencies must **meet a minimum of 75 percent (9 of 12)**. Agencies have flexibility to focus on the criteria that are most applicable to the building and account for life cycle cost effectiveness, mission requirements, and unique project scopes.

If an agency determines that the building's inherent function, mission, safety, or designation precludes it from meeting the minimum threshold of requisite criteria in a life cycle cost-effective manner as outlined above, the building would not qualify as a sustainable Federal building under this Guidance. For the purposes of supporting the policy outlined in this Guidance, those buildings that have met as many of the requisite criteria that are life cycle cost-effective may be designated as a Federal high-performance building (42 U.S.C § 17061(12)).

Agencies should continue to ensure all Federal statutes applicable to the project or building are met, regardless of whether the building is able to achieve the minimum criteria to be qualified as a sustainable Federal building.

REFERENCE KEY

S	Criteria that are based on and reference statutory or regulatory requirements are indicated with "S" on the checklist. "S*" indicates NDAA-aligned criteria that are applicable to the U.S. Department of Defense (DoD).
Std	Criteria that are based on green building industry standards, rather than statutory or regulatory requirements, are indicated with "Std" on the checklist.
[C/I]	Criteria where campus-wide or installation-wide protocols, policies, contracts can be used to demonstrate, upon assessment, that the criteria were met at the building level are indicated on the checklist with a [C/I].

<table>
<tr><th colspan="4">1.0 - Employ Integrated Design Principles</th></tr>
<tr><td rowspan="2">NC&M Criteria 1.1</td><td rowspan="2">Integrated Design and Management</td><td colspan="2">CORE</td></tr>
<tr><td>(Std)</td><td></td></tr>
<tr><td colspan="4">Establish sustainability goals as part of the project to meet the Guiding Principles and incorporate those goals into the design document and process, such as the Owner's Project Requirements (OPR), Basis of Design (BOD), Conceptual Design Report (CDR), or relevant design documents.</td></tr>
<tr><td colspan="4">AND ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="3">Use a collaborative, integrated process and team tailored to the size and function of the building to plan, program, design, construct, commission, and transition to operation the building project or modernization. Identify team members and roles. Ensure energy, water, materials, indoor environmental quality, recycling and composting, occupant health and wellness, transportation (including public transit, safety, parking, and electric vehicle charging), siting and landscape, the protection of historic properties and other cultural resources, community integration, and building resilience are considered while balancing the building's function and mission throughout the design and construction of the building and into operations plans, where feasible.</td></tr>
<tr><td>Option 2</td><td colspan="3">Use an integrated design process consistent with 2018 International Green Construction Code (IgCC) Appendix F Integrated Design, including F101.1.1 (F1.1.1) Charrette Process (excluding F101.1.2 (F1.1.2) Design Charrette Matrix).</td></tr>
<tr><td rowspan="2">NC&M Criteria 1.2</td><td rowspan="2">Sustainable Siting</td><td colspan="2">CORE</td></tr>
<tr><td>(S)</td><td>[C/I]</td></tr>
<tr><td colspan="4">Follow all relevant requirements of 41 CFR § 102-76.20 of the Federal Management Regulation to make a positive contribution to the surrounding landscape, and comply with the National Environmental Policy Act of 1969, as amended, 42 U.S.C. 4321 et seq., and the National Historic Preservation Act of 1966, as amended, 54 U.S.C. Subtitle III, Division A.</td></tr>
<tr><td colspan="4">AND ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="3">In alignment with sustainable siting best practices, assess all relevant opportunities for enhancements to the site sustainability and engage building occupants and other stakeholders utilizing the site. The specific actions of the site selection and planning stage should reflect the complexity of the proposed building and include, as appropriate, the following: 1) avoid development of prime farmland; 2) preserve areas with permeable soils; 3) avoid or, if not possible, minimize potential harm to or within the floodplain; 4) protect and conserve existing landscapes, wetlands, forest, and wilderness areas; 5) minimize site disturbance; 6) preserve threatened or endangered species and their habitats, including pollinators' habitats; 7) improve linkages and connections to surrounding destinations and neighborhoods; 8) use historic properties, especially those located in central business districts; and 9) incorporate appropriate security design parameters. Incorporate these environmental considerations through a systematic interdisciplinary approach, and balance these concerns with cost and security. Agencies can reference additional siting resources, including GSA'S Sustainable Facilities Tool (SFTool) and the Environmental Protection Agency (EPA's) Smart Growth—Location and Green Building site, the U.S. Department of Agriculture's (USDA) pollinators resources, and for projects involving historic properties, the Secretary of the Interior's Standards for Rehabilitation & Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings.</td></tr>
<tr><td>Option 2</td><td colspan="3">Conform to 2018 IgCC Section 501.3.1 (5.3.1) Site Selection and 501.3.2 (5.3.2) Predesign Site Inventory and Assessment.</td></tr>
</table>

NC&M Criteria 1.3	Stormwater Management	CORE (S) [C/I]
CHOOSE ONE OF THE FOLLOWING OPTIONS:		
Option 1	For new construction or modernization projects disturbing a surface area of 5,000 or more square feet, use planning, design, construction, and maintenance strategies to maintain or restore the predevelopment hydrology of the property in terms of temperature, rate, volume, and duration of flow, in accordance with statutory requirements (42 U.S.C. § 17094). Low impact development (LID) infrastructure solutions can be utilized to help achieve this criteria.	
Option 2	For new construction or modernization projects disturbing a surface area fewer than 5,000 square feet, use site planning, design, construction, and maintenance strategies such as low impact development (LID) to manage on-site stormwater and to maintain or restore hydrologic conditions after development, to the maximum extent that is technically practicable.	
Option 3	Conform to 2018 IgCC Section 501.3.4 (5.3.4) Stormwater Management.	

NC&M Criteria 1.4	Infrastructure Utilization and Optimization	NON-CORE (Std) [C/I]
Evaluate and prioritize transportation strategies and associated infrastructure improvements that promote and support alternative transportation, including walking, cycling, alternative fuel and electric vehicles, and public transit over the life of the building, as feasible and consistent with the mission of the facility.		
AND ONE OF THE FOLLOWING OPTIONS:		
Option 1	Locate any functional entry of the project within a ¼-mile (400-meter) walking distance of existing or planned bus, streetcar, shuttle, or informal transit stops, or within a ½-mile (800-meter) walking distance of existing or planned bus rapid transit stops, light or heavy rail stations, commuter rail stations or ferry terminals, except for those facilities where their mission and function prevents mass transportation access.	
Option 2	Install electric vehicle charging stations for a minimum of two percent of the parking spaces created as part of the project or designated for the building occupants, where on-site vehicle parking is provided.	
Option 3	Designate at least five percent of the parking spaces created as part of the project or designated for the building occupants as preferred parking for alternative fuel vehicles (may include parking for agency fleet alternative fuel vehicles).	
Option 4	Provide an alternative transportation program to reduce congestion and the need for parking. The program may include transit services; walkability improvements including connections to transit, sidewalks, pathways, and bicycle trails; alternative transit education; designated rideshare areas; transit subsidies; telecommuting incentives; or bicycle racks and showers.	
Option 5	Prior to and during the space decision process, engage planning officials at the state, metropolitan, or municipal level to identify ways proposed agency actions can support community sustainability and potentially align with local and regional long range plans and objectives. Support and integrate proposed actions into the project.	
Option 6	Conform to 2018 IGCC Section 1001.3.2.4 (10.3.2.4) Transportation Management Plan and Section 501.3.7.3 (5.3.7.3) Site Vehicle Provisions.	

<table>
<tr><td>NC&M Criteria 1.5</td><td>Commissioning</td><td>CORE
(S)</td></tr>
<tr><td colspan="3">Employ commissioning, as defined per Section 432 of the Energy Independence and Security Act of 2007 ((42 U.S.C. 8253(f)(1)(A)), and tailored to the size and complexity of the building.</td></tr>
<tr><td colspan="3">AND ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="2">Document through a commissioning process that the building and its commissioned components, assemblies, and systems (including any renewable energy systems, thermal storage, district heating and cooling system, and cooling towers) comply with the owner’s project requirements. Conduct commissioning in accordance with the U.S. Department of Energy (DOE) Federal Energy Management Program's (FEMP) Commissioning for Federal Facilities guidance, using ANSI/ASHRAE/IES Standard 202 or other generally accepted engineering standards, guidelines, and nationally recognized organizations.

For less complex buildings, commissioning should be performed with generally accepted engineering standards acceptable to the agency.

A certified commissioning provider (may include a qualified agency employee), independent of the design and construction or operating team, should provide, within one year of project completion, a final commissioning report.</td></tr>
<tr><td>Option 2</td><td colspan="2">Conform to 2018 IgCC Section 1001.3.1.2 (10.3.1.2) Building Project Commissioning (Cx) Process.</td></tr>
</table>

2.0 Optimize Energy Performance

NC&M Criteria 2.1	Energy Efficiency	CORE (S)

For New Construction:

Ensure compliance with Federal energy efficiency performance requirements for new construction in accordance with § 109 of the Energy Policy Act of 2005 (42 U.S.C. § 6834(a)(3)(A)) and DOE's regulations as established under 10 CFR parts 433, subpart A, and 10 CFR parts 435, subpart A.

Ensure installation of ENERGY STAR and FEMP-designated products in all procurements involving energy-consuming products and services, in accordance with 42 U.S.C § 8259b and 10 CFR § 436.40–436.43.

For Modernization projects:

Ensure installation of ENERGY STAR and FEMP-designated products in all procurements involving energy-consuming products and services, in accordance with 42 U.S.C § 8259b and 10 CFR § 436.40–436.43.

Employ strategies to improve energy performance and reduce energy usage in accordance with 42 U.S.C. § 8253(a).

AND ONE OF THE FOLLOWING OPTIONS:

Option 1	Ensure building energy use is 20 percent below a FY 2015 energy use baseline.
Option 2	Ensure building energy use is 30 percent below a FY 2003 energy use baseline.
Option 3	Ensure the building has an ENERGY STAR score of 75 or higher.
Option 4	For building types not eligible to receive an ENERGY STAR score and where adequate benchmarking data exists, demonstrate that the building is in the top quartile of energy performance for its building type.
Option 5	Follow the Federal energy performance requirements established under 10 CFR Parts 433 and 435 by designing to exceed ANSI/ASHRAE/IES Standard 90.1 by at least 30 percent, where life cycle cost-effective.

NC&M Criteria 2.2	Energy Metering	CORE (S)

Install building-level meters for electricity and advanced meters to the maximum extent practicable, as required by EPAct 2005 § 103 (42 U.S.C. § 8253(e)). Install standard or advanced meters for natural gas and steam to the maximum extent practical, in accordance with the DOE's *Federal Building Metering Guidance* and EISA 2007 § 434 (42 U.S.C. § 8253(e)(1)).

<table>
<tr><td>NC&M Criteria 2.3</td><td colspan="2">Renewable Energy</td><td>NON-CORE
(S) [C/I]</td></tr>
<tr><td colspan="4">Evaluate applicable renewable electric energy strategies related to the project or building that could support, as needed, agency progress toward renewable energy goals where cost-effective, per 42 U.S.C. § 15852(a).

[Campus/Installation-wide approach can be utilized if the agency has assessed and can verify that the building will directly benefit from the renewable energy system. Alternatively, the agency should develop an internal energy accounting or tracking system to apportion renewable energy or attributes to the building to avoid any double counting.]</td></tr>
<tr><td colspan="4">AND ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="3">Implement, as appropriate, life cycle cost-effective on-site renewable electric or thermal energy projects.

Alternatively, utilize alternative energy systems such as waste heat, combined heat and power (CHP), or fuel cell energy systems, where life cycle cost-effective.

If on-site renewable energy or alternative energy systems are not technically feasible or life cycle cost-effective, the agency should establish an internal energy accounting or tracking system to apportion power purchases from off-site renewable sources or renewable energy certificates (RECs) to the building, as aligned with agency plans.</td></tr>
<tr><td>Option 2</td><td colspan="3">Where appropriate and life cycle cost-effective, not less than 30 percent of the hot water demand is to be met through the installation and use of solar hot water heaters, per 42 U.S.C § 6834(a)(3)(A)(iii).</td></tr>
<tr><td>Option 3</td><td colspan="3">Conform to 2018 IgCC Section 701.4.1.1 (7.4.1.1) On-Site Renewable Energy Systems or equivalent, with the exception that there is no minimum energy production (kBtu/ft^2) requirement.</td></tr>
<tr><td>NC&M Criteria 2.4</td><td colspan="2">Benchmarking</td><td>CORE
(S)</td></tr>
<tr><td colspan="4">CHOOSE ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="3">Benchmark building performance at least annually, preferably using ENERGY STAR Portfolio Manager, and regularly monitor building energy performance against historic performance data and peer buildings, in accordance with criteria established by DOE’s Federal Building Energy Use Benchmarking Guidance per 42 U.S.C. § 8253(f)(8).</td></tr>
<tr><td>Option 2</td><td colspan="3">Conform to 2018 IgCC Section 1001.3.2.1.3.2 (10.3.2.1.3.2) Track and Assess Energy Consumption.</td></tr>
</table>

3.0 - Protect and Conserve Water

NC&M Criteria 3.1	Indoor Water Use	CORE (S)
For new construction where water is used to achieve energy efficiency, water conservation measures must be applied to the extent that they are life cycle cost-effective in accordance with 10 CFR Parts 433 and 435. In addition to the use of water conservation technologies otherwise required by 42 U.S.C. § 6834, water conservation technologies are to be applied to the extent that the technologies are life cycle cost-effective for new construction and modernization projects, in accordance with 42 U.S.C. § 6834(a)(3)(D)(vii). Eliminate the use of single-pass (also called "once-through") cooling equipment using potable water and optimize cooling tower operations to minimize makeup water. Agencies should refer to EPA's WaterSense, GSA's SFTool: Water, and DOE-FEMP's Water Efficiency in Federal Buildings and Campuses resources for additional details on available water conservation technologies and best management practices.		
For New Construction:		
AND ONE OF THE FOLLOWING OPTIONS:		
Option 1	Install WaterSense equipment or equivalent alternatives, where available, for all fixtures that are designed to be used more than once per day on average over a month. For all fixtures and fittings using potable water with planned use of more than once per day, compile cut sheet or product declarations or plumbing schedule showing flush or flow rate performance meeting WaterSense or equivalent.	
Option 2	Conform to 2018 IgCC Section 601.3.2.1 (6.3.2.1) Plumbing Fixtures and Fittings or 601.3.2.6 (6.3.2.6) Medical and Laboratory Facilities (if applicable).	
For Modernization projects:		
AND ONE OF THE FOLLOWING OPTIONS:		
Option 1	Install WaterSense equipment or equivalent alternatives to demonstrate at least a 20 percent reduction when comparing installed fixture performance to a base case representing the code-minimum, using the FEMP Water Evaluation Data Tool or other water fixture performance calculator. For all fixtures and fittings using potable water with planned use of more than once a day, compile cut sheet or product declarations or plumbing schedule showing flush or flow rate performance consistent with WaterSense or equivalent.	
Option 2	Conform to 2018 IgCC Section 601.3.2.1 (6.3.2.1) Plumbing Fixtures and Fittings or 601.3.2.6 (6.3.2.6) Medical and Laboratory Facilities (if applicable).	

NC&M Criteria 3.2	Water Metering	CORE (Std)
AND ONE OF THE FOLLOWING OPTIONS:		
Option 1	Install building level water meters (standard or advanced) and monitor to ensure optimized management of water use during occupancy, including detection of leaks in accordance with DOE's *Federal Building Metering Guidance*.	
Option 2	Conform to 2018 IgCC Section 601.3.4.1 (6.3.4.1) Consumption Management.	

NC&M Criteria 3.3	Outdoor Water Use	NON-CORE (Std) [C/I]
Evaluate and implement, as applicable, water efficient landscaping best practices that incorporate native, non-invasive, drought tolerant, and low maintenance plant species. Utilize and follow, as appropriate, landscaping best practices provided by GSA's SFTool - Water resources, DOE-FEMP's Water Efficiency in Federal Buildings and Campuses resources, EPA's WaterSense - Outdoors resources, or an agency-approved tool.		
AND ONE OF THE FOLLOWING OPTIONS:		
Option 1	Employ water efficient irrigation strategies to reduce outdoor potable water consumption. Where installed, demonstrate that the permanent irrigation system uses 50 percent or less of the amount of potable water used in conventional practices, assuming typical annual baseline water use. Refer to DOE-FEMP's Water Efficiency in Federal Buildings and Campuses resource on establishing a baseline. Install water meters for irrigation systems serving more than 25,000 square feet of landscaping.	
Option 2	If installing landscaping, utilize xeriscaping techniques or do not irrigate beyond the establishment of plantings.	
Option 3	Conform to 2018 IgCC Section 601.3.1.1 (6.3.1.1) Landscape Design. If irrigation is used, conform to Section 601.3.1.2 (6.3.1.2) Irrigation and Section 601.3.4.1 (6.3.4.1) Consumption Management (for irrigated landscaped areas greater than 25,000 square feet).	

NC&M Criteria 3.4	Alternative Water	NON-CORE (Std) [C/I]
CHOOSE ONE OF THE FOLLOWING OPTIONS:		
Option 1	Implement life-cycle cost-effective methods to utilize alternative sources of water for indoor or outdoor use, such as harvested rainwater, treated wastewater, air handler condensate capture, grey water, and reclaimed water, where permitted by local laws and regulations.	
Option 2	Implement life-cycle cost-effective methods to utilize alternative sources of water that conform to the 2018 IgCC Definition of Water, Alternative on-site sources.	

<table>
<tr><th colspan="4">4.0 - Enhance the Indoor Environment</th></tr>
<tr><td rowspan="2">NC&M Criteria 4.1</td><td rowspan="2">Ventilation and Thermal Comfort</td><td colspan="2">CORE</td></tr>
<tr><td>(S)</td><td></td></tr>
<tr><td colspan="4">CHOOSE ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="3">In accordance with 41 CFR §§ 102-74.195 and 102-74.185 of the Federal Management Regulation, comply with all ventilation and thermal comfort requirements. Utilize the most current version of ASHRAE “Ventilation for Acceptable Indoor Air Quality” Standard 62.1 or 62.2 and ASHRAE 55 "Thermal Environmental Conditions for Human Occupancy" as specified by the Federal Management Regulation. Agencies should refer to the GSA’s SFTool Enhancing Health with Indoor Air resources on enhancing indoor air quality.</td></tr>
<tr><td>Option 2</td><td colspan="3">Conform to 2018 IgCC Sections 801.3.1 (8.3.1) Indoor Air Quality and 801.3.2 (8.3.2) Thermal Environmental Conditions for Human Occupancy.</td></tr>
<tr><td rowspan="2">NC&M Criteria 4.2</td><td rowspan="2">Daylighting and Lighting Controls</td><td colspan="2">NON-CORE</td></tr>
<tr><td>(S)</td><td></td></tr>
<tr><td colspan="4">Design and construct the building to meet and maintain all required illumination levels, in accordance with 41 CFR § 102-74.180 of the Federal Management Regulation, and maximize the use of automatic dimming controls or accessible manual controls in regularly occupied spaces.</td></tr>
<tr><td colspan="4">AND ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="3">Improve access to and benefits from daylight by ensuring regularly occupied spaces along the exterior wall have fenestration, and control solar gain, daylight transmittance, and glare. If the building cannot achieve adequate daylighting due to mission or security needs, utilize circadian-effective lighting based on computer analysis or simulation tools to design optimal lighting conditions for the regularly occupied spaces. Evaluate and assess occupant workplace to allow more open space around windows, except where not appropriate because of building function, mission, or structural constraints.</td></tr>
<tr><td>Option 2</td><td colspan="3">Conform to 2018 IgCC Sections 801.3.7 (8.3.7) Glare Control, 801.4.1.1.1 (8.4.1.1.1) Minimum Daylight Area, and 801.4.1.2 (8.4.1.2) Minimum Sidelighting Effective Aperture for Office Spaces and Classrooms, and 801.4.1.3 (8.4.1.3) Shading for Offices; or 801.5.1 (8.5.1) Daylight Simulation.</td></tr>
<tr><td rowspan="2">NC&M Criteria 4.3</td><td rowspan="2">Low-Emitting Materials and Products</td><td colspan="2">NON-CORE</td></tr>
<tr><td>(Std)</td><td>[C/I]</td></tr>
<tr><td colspan="4">CHOOSE ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="3">Utilize low-emitting (low or no volatile organic compound (VOC)) materials, on at least 75 percent of interior products by cost or surface area, for the following materials and products: composite wood products, flooring and carpet systems, wall panels, insulation, adhesives, sealants, interior paints and finishes, solvents, janitorial supplies, and furnishings. Agencies should refer to EPA’s Volatile Organic Compounds’ Impact on Indoor Air Quality resources for information on low-emitting products.</td></tr>
<tr><td>Option 2</td><td colspan="3">Conform to 2018 IgCC Section 801.4.2 (8.4.2) Materials or Section 801.5.2 (8.5.2) Materials.</td></tr>
</table>

NC&M Criteria 4.4	**Radon Mitigation**	**CORE** (S) [C/I]
CHOOSE ONE OF THE FOLLOWING OPTIONS:		
Option 1	In accordance with 41 CFR § 102-80.20 of the Federal Management Regulation, test for radon and mitigate high levels to maintain a level at or below 4 pCi/L (picocuries/liter).	
Option 2	Conform to 2018 IgCC Section 1001.3.1.9 (10.3.1.9) Soil-Gas Control.	

NC&M Criteria 4.5	**Moisture and Mold Control**	**NON-CORE** (Std)
CHOOSE ONE OF THE FOLLOWING OPTIONS:		
Option 1	Implement a moisture control strategy (may be part of the operations and maintenance protocols) for controlling moisture flows and condensation to prevent building damage, minimize mold contamination, and reduce health risks related to moisture.	
Option 2	Conform to 2018 IgCC Section 801.3.6 (8.3.6) Moisture Control.	

NC&M Criteria 4.6	**Indoor Air Quality during Construction**	**NON-CORE** (Std)
CHOOSE ONE OF THE FOLLOWING OPTIONS:		
Option 1	Develop and implement a plan to protect indoor air quality during construction.	
Option 2	Conform to 2018 IgCC Sections 1001.3.1.5 (10.3.1.5) IAQ Construction Management, and 1001.3.1.8 (10.3.1.8) Construction Activity Pollution Prevention: Protection of Occupied Areas.	

NC&M Criteria 4.7	**Environmental Smoking Control**	**CORE** (S) [C/I]
CHOOSE ONE OF THE FOLLOWING OPTIONS:		
Option 1	In accordance with 41 CFR § 102-74.315 and 102-74.330 of the Federal Management Regulation, prohibit smoking in any form inside and within 25 feet of all building entrances, operable windows, and building ventilation intakes. Ensure signage is installed as appropriate.	
Option 2	Conform to 2018 IgCC Section 801.3.1.7 (8.3.1.7) Environmental Tobacco Smoke.	

<table>
<tr><td rowspan="2">NC&M Criteria 4.8</td><td rowspan="2">Integrated Pest Management</td><td colspan="2">CORE</td></tr>
<tr><td>(S)</td><td>[C/I]</td></tr>
<tr><td colspan="4">In accordance with 41 CFR § 102-74.35 of the Federal Management Regulation, ensure effective and environmentally sensitive integrated pest management (IPM) services including the planning, development, operations, and maintenance for pest control, removal, and prevention in both indoor and outdoor spaces. Ensure that pest management contracts are effectively coordinated with the activities of other building service programs that have a bearing on pest activity, such as food service, landscaping, child care, waste management, and repairs and operations.

Refer to GSA's IPM definition, EPA's IPM resources, and GSA's SFTool Pest Management resources for additional program guidance.</td></tr>
</table>

<table>
<tr><td colspan="2" rowspan="2">NC&M Criteria 4.9</td><td rowspan="2">Occupant Health and Wellness</td><td colspan="2">CORE</td></tr>
<tr><td>(Std)</td><td></td></tr>
<tr><td colspan="5">CHOOSE ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="4">Evaluate the feasibility of implementing occupant health and wellness efforts and promote two or more strategies that are cost-effective and applicable to the building mission.

Agencies are encouraged to assess and promote universally accepted workplace occupant health and wellness strategies most appropriate to their building and mission. Agencies should refer to GSA's SFTool for additional strategies and guidance on health and wellness in Federal facilities.

Examples of common health and wellness strategies include, but are not limited to:
1) Implementing biophilic design strategies that connect a majority of interior spaces with nature, using views, finishes, plants, daylighting, outdoor access, or other strategies;
2) Providing healthy dining options in the building or on campus that support offering a variety of fresh food options for occupants, following the U.S Department of Health and Human Services (HHS) / GSA Health and Sustainability Guidelines for Federal Concessions and Vending Operations where appropriate;
3) Designing stairwells as a desirable option for circulation to support active occupants;
4) Implementing a fitness program, including constructing or providing access to a fitness center or multi-use space for exercise in the building, on-site, or on campus;
5) Installing bicycle parking with safe, secure storage;
6) Providing adjustable-height desks or computer risers for 25 percent of the regular occupied spaces; and
7) Providing water bottle-refilling stations, establish a process to test water quality annually, and ensure proper maintenance of the stations. Refer to EPA's Drinking Water resources for additional guidelines.</td></tr>
<tr><td>Option 2</td><td colspan="4">Achieve certification utilizing any Health & Wellness Standards and Rating System identified by GSA, under its authorities per 42 U.S.C. § 17092.</td></tr>
</table>

5.0 - Reduce the Environmental Impact of Materials

NC&M Criteria 5.1	Materials - Recycled Content	CORE (S)	CORE [C/I]

Use Resource Conservation and Recovery Act (RCRA) section 6002 compliant products that meet or exceed EPA's Comprehensive Procurement Guideline Program, which provides recycled content recommendations for building construction, modifications, operations, and maintenance, in accordance with 42 U.S.C. § 6962 et seq.

NC&M Criteria 5.2	Materials - Biobased Content	CORE (S)	CORE [C/I]

Use U.S. Department of Agriculture (USDA) BioPreferred products, which are designated products with the highest content level per USDA's biobased content recommendations, in accordance with 7 U.S.C. § 8102.

NC&M Criteria 5.3	Products	NON-CORE (Std)	

CHOOSE ONE OF THE FOLLOWING OPTIONS:

Option 1	Use construction products and building supplies recommended under EPA's Recommendations of Specifications, Standards, and Ecolabels for Federal Purchasing, as appropriate and applicable.
Option 2	Conform to 2018 IgCC Section 901.4.1.4 (9.4.1.4) Multiple-Attribute Product Declaration or Certification.

NC&M Criteria 5.4	Ozone Depleting Substances	CORE (S)	CORE [C/I]

CHOOSE ONE OF THE FOLLOWING OPTIONS:

Option 1	Ensure compliance with 42 U.S.C. § 7671k and 42 U.S.C. § 7671*l*, concerning the procurement of safe alternatives for ozone depleting substances. Maximize the use of safe alternatives, where EPA's Significant New Alternative Policy (SNAP) Program has identified acceptable substitutes and alternatives. Refer to EPA's SNAP regulations, 40 CFR part 82, which list substitutes that have been determined unacceptable, acceptable to use conditions, and acceptable subject to narrowed use limits.
Option 2	Conform to 2018 IgCC Section 901.3.3 (9.3.3) Refrigerants.

<table>
<tr><td>NC&M Criteria 5.5</td><td>Hazardous Waste</td><td colspan="2">CORE</td></tr>
<tr><td></td><td></td><td>(S)</td><td></td></tr>
<tr><td colspan="4">Ensure compliance with all relevant hazardous waste construction or operational activities that are covered by RCRA subtitle C and subtitle I and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), per 42 U.S.C. § 9601 et seq. and its implementing regulations at 40 CFR Parts 239-282.

This criterion is achieved so long as it can be demonstrated that the building has a program and procedure to manage hazardous waste, or the building does not generate, store, treat, or dispose of hazardous waste. (40 CFR §§ 260.10 and 261.3).</td></tr>
</table>

<table>
<tr><td colspan="2">NC&M Criteria 5.6</td><td>Solid Waste Management</td><td colspan="2">NON-CORE</td></tr>
<tr><td colspan="2"></td><td></td><td>(Std)</td><td></td></tr>
<tr><td colspan="5">CHOOSE ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="4">Develop and implement a construction and demolition waste management plan. Where markets exist, divert at least 50 percent of construction and demolition materials from landfills and non-energy generating incinerations, as defined by and in alignment with EPA’s Waste Management Hierarchy.

AND

Design the building to incorporate appropriate space, equipment, and transport accommodations for collection, storage, and staging of recyclables and, as appropriate, compostable materials.</td></tr>
<tr><td>Option 2</td><td colspan="4">Conform to 2018 IgCC Section 901.3.1.1 (9.3.1.1) Diversion.

AND

Conform to 2018 IgCC Section 901.3.4 (9.3.4) Areas for Storage and Collection of Recyclables and Discarded Goods.</td></tr>
</table>

6.0 - Assess and Consider Building Resilience		
NC&M Criteria 6.1	**Risk Assessment**	**NON-CORE** **S*** **[C/I]**
CHOOSE ONE OF THE FOLLOWING OPTIONS:		
Option 1	Conduct a regionally tailored risk assessment for the site that, where appropriate, aims to: **1.** Assess long-term mission critical functions over the intended service life by incorporating considerations such as mission needs, building functions, occupants, and operations. Consider impacts to the surrounding community and to building operational needs. **2.** Assess the localized risks to the design life of the building, which involves identifying hazards, threats, vulnerabilities, and consequences. During the hazard identification step, identify and review any known observed and expected long-term weather-related and geographical hazards to inform and enhance the resilience of the building design and operations. **3.** Assess relevant stressors that could exacerbate hazards and risks to the building and operations. Account for whether the frequency is increasing, remaining the same, or decreasing in the specific region. **4.** Evaluate and consider the adaptive capacity of the building and operations to cope with shocks and stressors, or ability to adjust to new situations. **5.** Incorporate, as applicable, a comprehensive energy and water infrastructure assessment to ensure resilience and investigate alternative energy sources to serve as back-up power.	
Option 2	Ensure that the building, as well as any planned mission critical activities housed in the building, have been evaluated and integrated as part of a recent agency, facility, installation, or campus resilience or adaptation assessment. This can include any resilience and adaptation assessment activities associated with Installation Master Plans, climate adaptation plans, or equivalent agency, installation, or campus resilience or adaptation plans.	
Option 3	Utilize available Federal climate resilience planning tools to inform the decision making and design for the building project. Available tools include the U.S. Climate Resilience Toolkit, the Naval Facilities Engineering Command's Climate Change Installation Adaptation and Resilience Planning Handbook, the NIST Community Resilience Planning Guide for Buildings and Infrastructure Systems, the NIST EDGe$ (Economic Decision Guide Software) Online Tool, the U.S. Army Corps of Engineers climate preparedness and resilience planning tools, the U.S. Department of the Army's Climate Assessment Tool and Climate Resilience Handbook, FEMP's Technical Resilience Navigator, or any other Federal agency-developed climate resilience or adaptation planning tools that become available.	

NC&M Criteria 6.2	**Building Resilience and Adaptation**	**NON-CORE** **S*** **[C/I]**
CHOOSE ONE OF THE FOLLOWING OPTIONS:		
Option 1	Utilize the risk assessment to determine and prioritize design parameters that should be incorporated to ensure resilient building design and operations over the intended service life of the building, considering mission criticality, cost, and security. Ensure the implementation of no cost and cost-effective climate resilience measures, and, where feasible, implement solutions that focus on operations. Consider in the operation plans of the building, facility, campus, or installation, the adaptive capacity of the building to cope with stressors and mitigate based on mission criticality and cost. Identify and implement measures, where appropriate, to support passive survivability and functionality during emergencies.	
Option 2	Ensure the implementation of cost-effective strategies identified through an agency developed resilience or adaptation plans or any other Federal agency developed climate resilience or risk assessment planning tools. (For examples of available tools, refer to criteria 6.1.)	

Appendix B

Assessing a Building Using the
Guiding Principles for Sustainable Federal Buildings Criteria Checklist for

Existing Buildings (EB)

This Guiding Principles for Sustainable Federal Buildings Criteria Checklist is a tool that agencies may use to demonstrate that an **existing building** meets the intent of the Guiding Principles. Criteria on the checklist include both design elements for renovation projects and operational and maintenance procedures that can be used to demonstrate continued operation as a sustainable Federal building.

Instructions for EB:

The Existing Buildings checklist contains 30 criteria for agencies to assess in order to demonstrate that the building meets the policy outlined in this Guidance. All criteria should be considered as part of the initial assessment process and throughout the design and construction of the project.

> **Core Criteria:** Twelve core criteria, supported by statutory and regulatory requirements and green building industry standards, are considered fundamental principles for any Federal high-performance green building (42 U.S. Code § 17061(13)). **To qualify as a sustainable Federal building under this Guidance the building must meet all 12 of the core criteria.**
>
> **Non-Core Criteria:** For the remaining 18 criteria that are not indicated as core, agencies must **meet a minimum of 50 percent (9 of 18)**. Agencies have flexibility to focus on the criteria that are most applicable to the building and account for life cycle cost effectiveness, mission requirements, and unique project scopes.

If an agency determines that the building's inherent function, mission, safety, or designation precludes it from meeting the minimum threshold of requisite criteria in a life cycle cost-effective manner as outlined above, the building would not qualify as a sustainable Federal building under this Guidance. For the purposes of supporting the policy outlined in this Guidance, those buildings that have met as many of the requisite criteria that are life cycle cost-effective may be designated as a Federal high-performance building (42 U.S.C § 17061(12)).

Agencies should continue to ensure all Federal statutes applicable to the project or building are met, regardless of whether the building is able to achieve the minimum criteria to be qualified as a sustainable Federal building.

REFERENCE KEY

S	Criteria that are based on statutory or regulatory requirements are indicated with "S" on the checklist. "S*" indicates an NDAA aligned criteria that are applicable to the Department of Defense (DoD).
Std	Criteria that are based on green building industry standards, rather than statutory or regulatory requirements, are indicated with "Std" on the checklist.
[C/I]	Criteria where campus-wide or installation-wide protocols, policies, contracts can be used to demonstrate, upon assessment, that the criteria was met at the building level are indicated on the checklist with a [C/I].

<table>
<tr><th colspan="4">1.0 - Employ Integrated Design Principles</th></tr>
<tr><td rowspan="2">EB Criteria 1.1</td><td rowspan="2">Integrated Design and Management</td><td colspan="2">CORE</td></tr>
<tr><td>(Std)</td><td></td></tr>
<tr><td colspan="4">Ensure that sustainability goals for the operation of the building are established and are incorporated into the building's Operations and Maintenance (O&M) procedures. If a renovation project is planned in the building, ensure that sustainability goals have been developed as part of the project to meet the Guiding Principles and that they are incorporated into applicable project design documents.</td></tr>
<tr><td colspan="4">AND ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="3">Use a collaborative, integrated process team tailored to the size and function of the building to plan, program, operate, and maintain the building. Ensure opportunities to optimize energy, water, materials, indoor environmental quality, recycling and composting, occupant health and wellness, transportation (including public transit, safety, parking, and electric vehicle charging), siting and landscape, the protection of historic properties and other cultural resources, community integration, and building resilience continue to be considered, supporting the building’s function and mission throughout the life of the building.</td></tr>
<tr><td>Option 2</td><td colspan="3">For buildings with renovation projects, use a collaborative, integrated process and team tailored to the size and function of the building to plan, program, design, construct, commission, and transition to operation the building renovation. Identify team members and roles. Ensure all opportunities from Option 1 are considered in the project.</td></tr>
<tr><td>Option 3</td><td colspan="3">For buildings with renovation projects, use an integrated design process consistent with 2018 IgCC Appendix F Integrated Design.</td></tr>
<tr><td rowspan="2">EB Criteria 1.2</td><td rowspan="2">Sustainable Siting</td><td colspan="2">NON-CORE</td></tr>
<tr><td>(S)</td><td>[C/I]</td></tr>
<tr><td colspan="4">Follow all relevant requirements of 41 CFR § 102-76.20 of the Federal Management Regulation to make a positive contribution to the surrounding landscape, and comply with the National Environmental Policy Act of 1969, as amended, 42 U.S.C. § 4321 et seq., and the National Historic Preservation Act of 1966, as amended, 54 U.S.C. Subtitle III, Division A.</td></tr>
<tr><td colspan="4">AND ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="3">In alignment with sustainable siting best practices, assess any relevant opportunities for continued protections and potential enhancements to the site’s sustainability and engage with building occupants. The specific actions of the site enhancements or optimization should reflect the scope and complexity of the proposed project or building and include, as applicable and technically feasible, the following: 1) mitigate any potential or existing impacts to neighboring prime farmland; 2) take action to enhance, mitigate, and preserve existing areas with permeable soils; 3) minimize potential harm to or within the floodplain; 4) protect and conserve existing landscapes, wetlands, forest, and wilderness areas; 5) if impacting site, minimize site disturbance; 6) implement policies and programs to preserve threatened or endangered species and their habitats, including pollinators’ habitats; 7) optimize linkages and connections to surrounding destinations and neighborhoods; 8) continue use of historic properties, especially those located in central business districts; and 9) enhance appropriate security design parameters.</td></tr>
</table>

	Incorporate these environmental considerations through a systematic interdisciplinary approach, and balance these concerns with cost and security. Agencies can reference additional siting resources from GSA'S Sustainable Facilities Tool (SFTool) and the Environmental Protection Agency (EPA's) Smart Growth—Location and Green Building site, the U.S. Department of Agriculture's (USDA) pollinators resources, and for projects involving historic properties, the Secretary of the Interior's Standards for Rehabilitation & Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings.
Option 2	In the case of full or partial building renovation projects, use an integrated design process to apply 2018 IgCC Section 501.3.1 (5.3.1) Site Selection and Section 501.3.2 (5.3.2) Predesign Site Inventory and Assessment as applicable.

EB Criteria 1.3	**Stormwater Management**	**NON-CORE**	
		(S)	**[C/I]**
CHOOSE ONE OF THE FOLLOWING OPTIONS:			
Option 1	Employ or maintain strategies, such as low impact development (LID), that reduce stormwater runoff and discharges of polluted water offsite to protect the natural hydrology and watershed health.		
Option 2	For buildings with renovation projects disturbing a surface area of 5,000 or greater square feet, use planning, design, construction, and maintenance strategies to maintain or restore the predevelopment hydrology of the property in terms of temperature, rate, volume, and duration of flow, in accordance with statutory requirements (42 U.S.C. § 17094).		
Option 3	For buildings with renovation projects disturbing fewer than 5,000 square feet, use site planning, design, construction, and maintenance strategies, such as Low Impact Development (LID), to manage on-site stormwater and to maintain or restore hydrologic conditions after development, to the maximum extent that is technically practicable.		

EB Criteria 1.4	**Infrastructure Utilization and Optimization**	**NON-CORE**	
		(Std)	**[C/I]**
Assess existing transit opportunities and prioritize transportation strategies that promote alternative transportation. These strategies may include commuting programs, cycling, alternative fuel vehicles, electric vehicles, walkability factors, and transit incentives applicable to the building. Include the building in any master planning related to transportation, and building occupants should be able to participate in all transport.			
AND ONE OF THE FOLLOWING OPTIONS:			
Option 1	Assess and develop plans to optimize or facilitate building occupants' access (within walking distance), to existing or planned bus, streetcar, shuttle, and rapid transit stops; light or heavy rail stations; commuter rail stations; or ferry terminals. Ensure a program is in place that reviews and alerts building occupants of new services and opportunities.		
Option 2	Consistent with 42 U.S.C. § 6364, establish an electric vehicle supply equipment (EVSE) policy and install one or more electric vehicle charging stations if parking is provided.		
Option 3	Verify that building occupants are able to access preferred parking for alternative fuel vehicles (may include parking for agency fleet alternative fuel vehicles).		
Option 4	Provide an alternative transportation program consisting of a combination of transit services to support walkability and connection to transportation networks, including pedestrian access to sidewalks, pathways, and bicycle trails, to reduce transportation congestion and parking. The program may include alternative transit education, preferred parking for rideshare vehicles, transit discounts, telecommuting, and bicycle racks.		
Option 5	Conform to 2018 IGCC Section 1001.3.2.4 (10.3.2.4) Transportation Management Plan and Section 501.3.7.3 (5.3.7.3) Site Vehicle Provisions.		

<table>
<tr><th rowspan="2">EB Criteria 1.5</th><th rowspan="2">Commissioning</th><th colspan="2">CORE</th></tr>
<tr><th>(S)</th><th></th></tr>
<tr><td colspan="4">Employ commissioning based on the designation of the building per Section 432 of the Energy Independence and Security Act of 2007 (42 U.S.C. § 8253(f)(2)(B))) and tailored to the size and complexity of the building.</td></tr>
<tr><td colspan="4">AND ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="3">For a building identified as a “covered facility” (42 U.S.C. § 8253(f)(2)(B)):
Ensure compliance with 42 U.S.C. § 8253(f)(3)(B) to identify and assess (re/retro-) commissioning measures for the facility in accordance with FEMP guidance, Facility Energy Management Guidelines and Criteria for Energy and Water Evaluations in Covered Facilities and Commissioning for Federal Facilities guidance.

The “Exclusion of Small Facilities” pertaining to commissioning as outlined in FEMP’s Facility Energy Management Guidelines and Criteria for Energy and Water Evaluations in Covered Facilities cannot be used to exempt the building from this criteria.</td></tr>
<tr><td>Option 2</td><td colspan="3">For a building not identified as a “covered facility” (42 U.S.C. § 8253(f)(2)(B)):
Ensure the building has previously been commissioned, recommissioned, or retro-commissioned and has not had a major change in mission or function, occupancy, energy consumption, water consumption, or major facility upgrades, or renovations since previous commissioning.

If the building has not previously been commissioned or major changes have occurred, identify and assess (re/retro-) commissioning measures for the facility, in accordance with FEMP’s Commissioning for Federal Facilities guidance.</td></tr>
<tr><td>Option 3</td><td colspan="3">For either a “covered” or “non-covered” facility (42 U.S.C. § 8253(f)(2)(B)):
Implement ongoing commissioning in accordance with FEMP's Commissioning for Federal Facilities guidance, which identifies on-going commissioning as an appropriate pathway for large and complex facilities with high energy use and/or frequent tenant complaints.

For covered facilities, ensure compliance with all statutory reporting requirements, per 42 U.S.C. § 8253(f)(3)(B), when using on-going commissioning.</td></tr>
</table>

2.0 Optimize Energy Performance

EB Criteria 2.1	Energy Efficiency	CORE (S)

Employ strategies to improve energy performance and reduce energy usage, and, for all procurements involving energy-consuming products and services, incorporate energy-efficiency criteria consistent with ENERGY STAR and FEMP-designated energy-efficient products, in accordance with 42 U.S.C § 8259b (10 CFR §§ 436.40-436.43).

AND ONE OF THE FOLLOWING OPTIONS:

Option 1	Ensure that the building energy use is 20 percent below a FY 2015 energy use baseline. Engineering or energy estimates based on the size, function, and complexity of the building may be used in cases where the building is part of a facility that shares a meter per DOE's *Federal Building Metering Guidance*. If baseline year data is not available or reliable, data from the earliest post-baseline year that is available and reliable can be used.
Option 2	Ensure that the building energy use is 30 percent below a FY 2003 energy use baseline. Engineering or energy estimates based on the size, function, and complexity of the building may be used in cases where the building is part of a facility that shares a meter per DOE's *Federal Building Metering Guidance*. If baseline year data is not available or reliable, data from the earliest post-baseline year that is available and reliable can be used.
Option 3	Ensure the building has an ENERGY STAR score of 75 or higher.
Option 4	For building types not eligible to receive an ENERGY STAR score and where adequate benchmarking data exists, demonstrate that the building is in the top quartile of energy performance for its building type.
Option 5	For buildings with renovation projects, conform to Federal design energy performance specifications established under 10 CFR parts 433, subpart A, and 10 CFR parts 435, subpart A by designing the building to exceed ANSI/ASHRAE/IES Standard 90.1 by at least 30 percent, where life cycle cost-effective.

EB Criteria 2.2	Energy Metering	CORE (S)

Verify the use of existing meters or, if no meter exists, install building-level meters or advanced meters to the maximum extent practicable for electricity, and standard metering devices for natural gas and steam, in accordance with DOE's *Federal Building Metering Guidance*, per 42 U.S.C § 8253(e)(1).

In a case where shared infrastructure for a facility is served by one meter, the energy use of the building may be calculated and evaluated using engineering energy estimates based on the size, function, and complexity of the building.

<table>
<tr><td colspan="2">EB Criteria 2.3</td><td>Renewable Energy</td><td>NON-CORE
(S) | [C/I]</td></tr>
<tr><td colspan="4">Evaluate applicable renewable electric energy strategies related to the project or building that could support, as needed, agency progress toward meeting renewable energy goals where cost-effective, per 42 U.S.C. § 15852(a).

[Campus/Installation-wide approach can be utilized if the agency has assessed and can verify that the building will directly benefit from the renewable energy system. Alternatively, the agency should develop an internal energy accounting or tracking system to apportion renewable energy or attributes to the building to avoid any double counting.]</td></tr>
<tr><td colspan="4">AND ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="3">Implement, as appropriate, life cycle cost-effective on-site renewable electric or thermal energy projects.

Alternatively, utilize alternative energy systems such as waste heat, combined heat and power (CHP), or fuel cell energy systems, where life cycle cost-effective.

As provided for in section III.A.2 of the E.O. 13834 Implementing Instructions, if on-site renewable energy or alternative energy systems are not technically feasible or life cycle cost-effective, the agency should establish an internal energy accounting or tracking system to apportion power purchases from off-site renewable sources or renewable energy certificates (RECs) to the building, as aligned with agency plans.</td></tr>
<tr><td>Option 2</td><td colspan="3">For buildings with renovation projects, conform to 2018 IgCC Section 701.4.1.1 (7.4.1.1) On-Site Renewable Energy Systems, with the exception that there is no minimum energy production (kBtu/ft^2) requirement.</td></tr>
<tr><td colspan="2">EB Criteria 2.4</td><td>Benchmarking</td><td>NON-CORE
(S) |</td></tr>
<tr><td colspan="4">Benchmark building performance at least annually and regularly monitor building energy performance against historical performance data and peer buildings, where feasible.</td></tr>
<tr><td colspan="4">CHOOSE ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="3">For a building identified as a “covered facility” (42 U.S.C. § 8253(f)(2)(B)): Benchmark building performance at least annually, preferably using ENERGY STAR Portfolio Manager, and regularly monitor building energy performance against historical performance data and peer buildings in accordance with DOE’s Federal Building Energy Use Benchmarking Guidance per 42 U.S.C. § 8253(f)(8).</td></tr>
<tr><td>Option 2</td><td colspan="3">For a building not identified as a “covered facility” (42 U.S.C. § 8253(f)(2)(B)): Benchmark using a system consistent with agency policy, including alternative benchmarking systems and/or strategies not subject to public disclosure, if applicable. Agencies can refer to DOE’s Federal Building Energy Use Benchmarking Guidance for additional resources.</td></tr>
<tr><td>Option 3</td><td colspan="3">For buildings with renovation projects, conform to 2018 IgCC Section 1001.3.2.1.3.2 (10.3.2.1.3.2) Track and Assess Energy Consumption.</td></tr>
</table>

3.0 - Protect and Conserve Water

EB Criteria 3.1	Indoor Water Use	CORE (S)
Employ strategies that minimize water use and verify purchasing policies or procedures are in place that require water efficient fixtures. Agencies should refer to EPA's WaterSense, GSA's SFTool - Water, and DOE-FEMP's Water Efficiency in Federal Buildings and Campuses resources for additional details on available water conservation technologies and best management practices.		
AND ONE OF THE FOLLOWING OPTIONS:		
Option 1	Ensure that water use is 20 percent below a FY 2007 water use baseline (from meter readings or engineering estimates). If baseline year data is not available or reliable, data from the earliest post-baseline year that is available and reliable can be used.	
Option 2	Conduct analysis showing at least a 20 percent reduction when comparing installed fixture performance to a base case that represents the code-minimum, using the FEMP Water Evaluation Data Tool or water fixture performance calculator.	
Option 3	To maximize water savings in HVAC systems, single-pass (also called "once-through") cooling equipment using potable water should be eliminated or retrofitted to recirculate or recapture discharge water in other applications (such as irrigation). Cooling towers should maximize cycles of concentration in accordance with 2018 IgCC Section 601.3.2.3 (6.3.2.3) HVAC Systems and Equipment.	
Option 4	Develop and implement a strategic water management plan in accordance with the applicable FEMP Best Management Practices (BMPs) for Water Efficiency.	

EB Criteria 3.2	Water Metering	NON-CORE (Std)
CHOOSE ONE OF THE FOLLOWING OPTIONS:		
Option 1	Install building level water meters (standard or advanced) and monitor to ensure optimized management of water use during occupancy, including detection of leaks, to the maximum extent practicable, in accordance with DOE's *Federal Building Metering Guidance*. In a case where shared infrastructure for a facility is served by one meter, the water use of each building may be calculated and evaluated using engineering water estimates based on the size, function, and complexity of the building. Agencies should refer to DOE-FEMP resources for additional details.	
Option 2	For buildings with renovation projects, conform to 2018 IgCC Section 601.3.4.1 (6.3.4.1) Consumption Management.	

EB Criteria 3.3	**Outdoor Water Use**	**NON-CORE (Std) [C/I]**
Evaluate and implement, as applicable, water efficient landscaping best practices that incorporate native, non-invasive, drought tolerant, and low maintenance plant species. Utilize and follow, as appropriate, landscaping best practices provided by GSA's SFTool - Water resources, DOE-FEMP's Water Efficiency in Federal Buildings and Campuses resources, EPA's WaterSense - Outdoors resources, or an agency-approved tool.		
AND ONE OF THE FOLLOWING OPTIONS:		
Option 1	Employ water efficient irrigation strategies to reduce outdoor potable water consumption. Where installed, demonstrate that the permanent irrigation system uses 50 percent or less of the amount of potable water used in conventional practices, assuming typical annual baseline water use. Refer to DOE-FEMP's Water Efficiency in Federal Buildings and Campuses resources on establishing a baseline. Install water meters for irrigation systems serving more than 25,000 square feet of landscaping.	
Option 2	If installing or using landscaping, utilize xeriscaping techniques or do not irrigate beyond the establishment or re-establishment of plantings.	
Option 3	Conform to 2018 IgCC Section 601.3.1.1 (6.3.1.1) Landscape Design. If irrigation is used, conform to Section 601.3.1.2 (6.3.1.2) Irrigation, and Section 601.3.4.1 (6.3.4.1) Consumption Management (for irrigated landscaped areas greater than 25,000 square feet).	

EB Criteria 3.4	**Alternative Water**	**NON-CORE (Std) [C/I]**
CHOOSE ONE OF THE FOLLOWING OPTIONS:		
Option 1	Implement, where technically feasible and permitted by local laws and regulations, methods to utilize alternative sources of water for indoor or outdoor use, such as harvested rainwater, treated wastewater, air handler condensate capture, grey water, and reclaimed water.	
Option 2	Implement methods to utilize alternative sources of water that conform to the 2018 IgCC Definition of Water, Alternative on-site sources.	

4.0 - Enhance the Indoor Environment

EB Criteria 4.1	Ventilation and Thermal Comfort	CORE	
		(S)	

CHOOSE ONE OF THE FOLLOWING OPTIONS:

Option 1	In accordance with 41 CFR §§ 102-74.195 and 102-74.185 of the Federal Management Regulation, comply with all ventilation and thermal comfort requirements. Agencies should refer to the GSA's SFTool - Enhancing Health with Indoor Air resources on enhancing indoor air quality.
Option 2	For buildings with renovation projects, conform to 2018 IgCC Sections 801.3.1 (8.3.1) Indoor Air Quality and 801.3.2 (8.3.2) Thermal Environmental Conditions for Human Occupancy.

EB Criteria 4.2	Daylighting and Lighting Controls	NON-CORE	
		(S)	

Verify the building maintains all required illumination levels, in accordance with 41 CFR § 102-74.180 of the Federal Management Regulation, and maximize the use of automatic dimming controls or accessible manual controls in regularly occupied spaces.

AND ONE OF THE FOLLOWING OPTIONS:

Option 1	Maximize access to and benefits of daylight by ensuring that regularly occupied spaces along the exterior wall have fenestration, and control solar gain, daylight transmittance, and glare. Evaluate and assess occupant workplaces to allow more open space around windows with appropriate glare controls, except where not appropriate because of building function, mission, or structural constraints.
Option 2	If the regularly occupied spaces do not have adequate daylighting, utilize circadian-effective lighting based on computer analysis or simulation tools to design optimal lighting conditions for regularly-occupied spaces.
Option 3	For buildings with renovation projects, conform to 2018 IgCC Sections 801.3.7 (8.3.7) Glare Control, 801.4.1 (8.4.1) Daylighting, 801.4.1.1.1 (8.4.1.1.1) Minimum Daylight Area, 801.4.1.2 (8.4.1.2) Minimum Sidelighting Effective Aperture for Office Spaces and Classrooms, and 801.4.1.3 (8.4.1.3) Shading for Offices; or 801.5.1 (8.5.1) Daylight Simulation.

EB Criteria 4.3	Low-Emitting Materials and Products	NON-CORE	
		(Std)	[C/I]

CHOOSE ONE OF THE FOLLOWING OPTIONS:

Option 1	Verify policy or purchasing procedures are in place to utilize low-emitting (low or no volatile organic compound (VOC)) materials. Applicable materials and products may include common supplies and replacements for composite wood products, flooring and carpet systems, wall panels, insulation, adhesives, sealants, interior paints and finishes, solvents, janitorial supplies, and furnishings. Agencies should refer to EPA's Volatile Organic Compounds' Impact on Indoor Air Quality resources for information on low-emitting products.
Option 2	Verify policy or purchasing procedures are in place that conform to 2018 IgCC Section 801.4.2 (8.4.2) Materials or Section 801.5.2 (8.5.2) Materials.

EB Criteria 4.4	**Radon Mitigation**	**CORE (S) [C/I]**
CHOOSE ONE OF THE FOLLOWING OPTIONS:		
Option 1	In accordance with 41 CFR § 102-80.20 of the Federal Management Regulation, test for radon in buildings and mitigate high levels to not exceed 4 pCi/L (picocuries/liter). Verify policy is in place that manages the process for testing and relevant mitigation activities to adequately protect occupant health.	
Option 2	Conform to 2018 IgCC Section 1001.3.1.9 (10.3.1.9) Soil-Gas Control.	

EB Criteria 4.5	**Moisture and Mold Control**	**NON-CORE (Std)**
CHOOSE ONE OF THE FOLLOWING OPTIONS:		
Option 1	Verify a moisture control and mitigation strategy is in place (may be part of operations and maintenance protocols) for controlling moisture flows and condensation to prevent building damage, minimize mold contamination, and reduce health risks related to moisture.	
Option 2	For buildings with renovation projects, conform to 2018 IgCC Section 801.3.6 (8.3.6) Moisture Control.	

EB Criteria 4.6	**Indoor Air Quality during Construction**	**NON-CORE (Std)**
CHOOSE ONE OF THE FOLLOWING OPTIONS:		
Option 1	Implement or verify a policy is in place to protect indoor air quality during operations as well as during any applicable renovations in the existing building. This may include strategies for having permanent entryway systems in place to capture dirt and particulates entering the building and specific procedures to protect occupants during renovations.	
Option 2	For buildings with renovation projects, conform to 2018 IgCC Sections 1001.3.1.5 (10.3.1.5) IAQ Construction Management, and 1001.3.1.8 (10.3.1.8) Construction Activity Pollution Prevention: Protection of Occupied Areas.	

EB Criteria 4.7	**Environmental Smoking Control**	**CORE (S) [C/I]**
CHOOSE ONE OF THE FOLLOWING OPTIONS:		
Option 1	In accordance with 41 CFR §§ 102-74.315 and 102-74.330 of the Federal Management Regulation, prohibit smoking in any form inside and within 25 feet of all building entrances, operable windows, and building ventilation intakes. Ensure signage is installed as appropriate.	
Option 2	Conform to 2018 IgCC Section 801.3.1.7 (8.3.1.7) Environmental Tobacco Smoke.	

<table>
<tr><td rowspan="2">EB Criteria 4.8</td><td rowspan="2">Integrated Pest Management</td><td colspan="2">NON-CORE</td></tr>
<tr><td>(S)</td><td>[C/I]</td></tr>
<tr><td colspan="4">In accordance with 41 CFR § 102-74.35 of the Federal Management Regulation, ensure effective and environmentally sensitive integrated pest management (IPM) services including the planning, development, operations, and maintenance for pest control, removal, and prevention in both indoor and outdoor spaces. Ensure that pest management service contracts are effectively coordinated with the activities of other building services that have a bearing on pest activity, such as food service, landscaping, child care, waste management, and repairs and operations.

Refer to GSA's IPM definition, EPA's IMP resources, and GSA's SFTool Pest Management resources for additional program guidance.</td></tr>
</table>

<table>
<tr><td rowspan="2" colspan="2">EB Criteria 4.9</td><td rowspan="2">Occupant Health and Wellness</td><td colspan="2">NON-CORE</td></tr>
<tr><td>(Std)</td><td></td></tr>
<tr><td colspan="5">CHOOSE ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="4">Evaluate the feasibility of implementing occupant health and wellness efforts and promote two or more strategies that are cost-effective and applicable to the building mission, or, if applicable, ensure continuation of already existing programs and efforts.

Agencies are encouraged to assess and promote universally accepted workplace occupant health and wellness strategies most appropriate to their building and mission. Agencies should refer to GSA's SFTool for additional strategies and guidance on health and wellness in Federal facilities.

Examples of common health and wellness strategies include, but are not limited to:
1) Implementing biophilic design strategies that connect a majority of interior spaces with nature, using views, finishes, plants, daylighting, outdoor access, or other strategies;
2) Providing healthy dining options (in the building or on campus) that support offering a variety of fresh food options for occupants, following the U.S Department of Health and Human Services (HHS) / GSA Health and Sustainability Guidelines for Federal Concessions and Vending Operations, where appropriate;
3) Designing stairwells as a desirable option for circulation to support active occupants;
4) Implementing a fitness program, including constructing or providing access to a fitness center or multi-use space for exercise in the building, on-site, or on campus;
5) Installing bicycle parking with safe, secure storage;
6) Providing adjustable-height desks or computer risers for 25% of the regular occupied spaces; and
7) Providing water bottle-refilling stations and establish a process to test water quality annually and ensure proper maintenance of the stations. Refer to EPA's Drinking Water resources for additional guidelines.</td></tr>
<tr><td>Option 2</td><td colspan="4">Complete section 2 (Health, Comfort and Performance) of GSA's Total Workplace Scorecard in its entirety.</td></tr>
<tr><td>Option 3</td><td colspan="4">Achieve certification utilizing any Health & Wellness Standards and Rating System identified by GSA, under its authorities per 42 U.S.C. § 17092.</td></tr>
</table>

<table>
<tr><th colspan="4">5.0 - Reduce the Environmental Impact of Materials</th></tr>
<tr><td rowspan="2">EB Criteria 5.1</td><td rowspan="2">Materials - Recycled Content</td><td colspan="2">CORE</td></tr>
<tr><td>(S)</td><td>[C/I]</td></tr>
<tr><td colspan="4">Verify that a policy or procedures are in place to procure and use Resource Conservation and Recovery Act (RCRA) section 6002 compliant products, which meet or exceed EPA’s Comprehensive Procurement Guideline Program, which provides recycled content recommendations, for operations and maintenance, in accordance with 42 U.S.C. § 6962 et seq.</td></tr>
<tr><td rowspan="2">EB Criteria 5.2</td><td rowspan="2">Materials - Biobased Content</td><td colspan="2">CORE</td></tr>
<tr><td>(S)</td><td>[C/I]</td></tr>
<tr><td colspan="4">Verify that a policy or procedures are in place to procure and use USDA BioPreferred products, which are designated products with the highest biobased content level per USDA’s recommendations, in accordance with 7 U.S.C. § 8102.</td></tr>
<tr><td rowspan="2">EB Criteria 5.3</td><td rowspan="2">Products</td><td colspan="2">NON-CORE</td></tr>
<tr><td>(Std)</td><td>[C/I]</td></tr>
<tr><td colspan="4">CHOOSE ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="3">Verify that a policy or procedures are in place to procure and use products recommended under EPA’s Recommendations of Specifications, Standards, and Ecolabels for Federal Purchasing, as appropriate and applicable.</td></tr>
<tr><td>Option 2</td><td colspan="3">For buildings with renovation projects, conform to 2018 IgCC Section 901.4.1.4 (9.4.1.4) Multiple-Attribute Product Declaration or Certification.</td></tr>
<tr><td rowspan="2">EB Criteria 5.4</td><td rowspan="2">Ozone Depleting Substances</td><td colspan="2">CORE</td></tr>
<tr><td>(S)</td><td>[C/I]</td></tr>
<tr><td colspan="4">CHOOSE ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="3">Verify that a policy or procedures are in place to procure and use safe alternatives for ozone depleting substances, in accordance with 42 U.S.C. § 7671k and 42 U.S.C. § 7671l. Maximize the use of safe alternatives, where EPA’s Significant New Alternative Policy (SNAP) Program has identified acceptable substitutes and alternatives.

Refer to EPA's SNAP regulations, 40 CFR part 82, which list substitutes that have been determined unacceptable, acceptable to use conditions, and acceptable subject to narrowed use limits.</td></tr>
<tr><td>Option 2</td><td colspan="3">For buildings with renovation projects, conform to 2018 IgCC Section 901.3.3 (9.3.3) Refrigerants.</td></tr>
</table>

<table>
<tr><td>EB Criteria 5.5</td><td>Hazardous Waste</td><td colspan="2">CORE</td></tr>
<tr><td></td><td></td><td>(S)</td><td></td></tr>
<tr><td colspan="4">Verify that a program or procedures are in place to ensure compliance with all relevant hazardous waste construction or operational activities that are covered by the Resource Conservation and Recovery Act (RCRA) subtitle C and subtitle I and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), per 42 U.S.C. § 9601 et seq. and its implementing regulations at 40 CFR Parts 239-282.

This criterion is achieved if it can be demonstrated that the building has a program and procedure in place to manage hazardous waste or does not generate, store, treat, or dispose of hazardous waste. (40 CFR §§ 260.10 and 261.3)</td></tr>
</table>

<table>
<tr><td>EB Criteria 5.6</td><td>Solid Waste Management</td><td colspan="2">NON-CORE</td></tr>
<tr><td></td><td></td><td>(Std)</td><td>[C/I]</td></tr>
<tr><td colspan="4">Verify a waste management and recycling policy, program, or procedures are in place.</td></tr>
<tr><td colspan="4">AND CHOOSE ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="3">Conduct an analysis or verify one has been done of non-hazardous, non-construction waste and develop a waste management plan or industry equivalent to increase waste diversion rate. Include in or ensure that the plan estimates waste types and amounts as well as goals for waste diversion to minimize waste sent to landfill.</td></tr>
<tr><td>Option 2</td><td colspan="3">Where markets exist, ensure diversion of at least 50 percent of non-hazardous and non-construction related materials from landfill and non-energy generating incineration, in alignment with EPA's Waste Management Hierarchy.</td></tr>
<tr><td>Option 3</td><td colspan="3">Conform to 2018 IgCC Section 901.3.4 (9.3.4) Areas for Storage and Collection of Recyclables and Discarded Goods.</td></tr>
<tr><td>Option 4</td><td colspan="3">For buildings with renovation projects, develop and implement a construction and demolition waste management plan for construction projects. Where markets exist, divert at least 50 percent of construction and demolition materials from landfill and non-energy generating incineration, in alignment with EPA's Waste Management Hierarchy.</td></tr>
</table>

<table>
<tr><th colspan="4">6.0 - Assess and Consider Building Resilience</th></tr>
<tr><td rowspan="2">EB Criteria 6.1</td><td rowspan="2">Risk Assessment</td><td colspan="2">NON-CORE</td></tr>
<tr><td>S*</td><td>[C/I]</td></tr>
<tr><td colspan="4">CHOOSE ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="3">Ensure the following are or have been incorporated into a site and facility risk assessment, where appropriate:
1. Assess long-term mission critical functions over the intended service life by incorporating considerations such as mission needs, building functions, occupants, and operations. Consider impacts to the surrounding community and to building operational needs.
2. Assess the localized risks to the operational life of the building which involves identifying hazards, threats, vulnerabilities, and consequences. During the hazard identification step, identify and review any known observed and expected long-term weather and geographic hazards to inform and enhance the resilience of the building design and/or operations.
3. Assess relevant stressors that could exacerbate hazards and risks to the building and operations, and factor in if their frequency is increasing, remaining the same, or decreasing in the specific region.
4. As part of any future portfolio planning, consider the potential for any adaptive capacity of the building and operations to cope with shocks, stressors, or ability to adjust to new situations.
5. Evaluate and incorporate, as applicable, a comprehensive energy and water infrastructure assessment to ensure resilience and investigate alternative energy sources to serve as back-up power.</td></tr>
<tr><td>Option 2</td><td colspan="3">Ensure that the building, as well as any planned mission critical activities housed in the building, have been evaluated and integrated as part of a recent agency, facility, installation, or campus resilience or adaptation assessment. This can include any other resilience and adaptation assessment activities associated with Installation Master Plans, climate adaptation plans, or equivalent agency, installation, or campus resilience or adaptation plans.</td></tr>
<tr><td>Option 3</td><td colspan="3">Utilize available Federal climate resilience planning tools to complete an assessment to inform decision making for the building project.

Available tools include the U.S. Climate Resilience Toolkit, the Naval Facilities Engineering Command’s Climate Change Installation Adaptation and Resilience Planning Handbook, the NIST Community Resilience Planning Guide for Buildings and Infrastructure Systems, the NIST EDGe$ (Economic Decision Guide Software) Online Tool, the U.S. Army Corps of Engineers climate preparedness and resilience planning tools, the U.S. Department of the Army’s Climate Assessment Tool and Climate Resilience Handbook, FEMP’s Technical Resilience Navigator, or any other Federal agency-developed climate resilience or adaptation planning tools that become available.</td></tr>
</table>

EB Criteria 6.2	Building Resilience and Adaptation	NON-CORE S* [C/I]
CHOOSE ONE OF THE FOLLOWING OPTIONS:		
Option 1	Utilize any current building or portfolio risk assessments to determine and prioritize which parameters have been or can be incorporated into the site or facility operations or planned renovation project to ensure resilient building design or operations over the intended service life, considering mission criticality, cost, and security. Consider, in the operation plans of the building, campus, or installation, the resilience and adaptive capacity of the building to cope with stressors and mitigate based on mission criticality and cost. Implement no cost and life cycle cost-effective climate resilience measures, where feasible. Consider the level of passive survivability and functionality during emergencies and integrate any applicable strategies into plans.	
Option 2	Implement or verify past implementation of applicable cost-effective strategies identified through an agency developed resilience or adaptation plan or any other Federal agency developed climate resilience or risk assessment planning tools. (For examples of available tools, refer to criteria 6.1.)	

Appendix C

Assessing a New Construction, Modernization, Major Renovation or Existing Building Using

Third-Party Building Certification Systems

As directed in the E.O. 13834 *Implementing Instructions*, the U.S. General Services Administration (GSA) has identified and recommended third-party building certification systems for qualifying sustainable Federal buildings for the purposes of meeting the policy outlined in this Guidance and in accordance with its authority under 42 U.S.C. § 17092(c). The independent and public review process used by GSA in developing its recommendations is provided in GSA's High-Performance Building Certification System Review Findings Report.

If agencies choose to use a third-party certification system to qualify their buildings as a sustainable Federal buildings, as provided by E.O. 13834 *Implementing Instructions*, agencies should use the third-party certification systems and the version or later indicated below, and agencies should ensure that the chosen system meets the criteria in 10 CFR 433.300 and 435.300, as applicable.

New Construction, Modernization and Major Renovations	
Agencies may qualify a new construction, modernization, or major renovations project as a sustainable Federal building by obtaining certification through one of the following third-party building certification systems, at the certification level indicated or higher.	
Option 1	LEED® v4 for Building Design and Construction (BD+C): Silver
Option 2	Green Globes® for New Construction, version 2013: 2 Globes
Existing Buildings	
Agencies may qualify an existing building as a sustainable Federal building by obtaining certification through one of the following third-party building certification systems, at the certification level indicated or higher.	
Option 1	LEED v4 for Building Operations and Maintenance (O+M): Silver
Option 2	Green Globes for Existing Buildings (EB), version 2013: 2 Globes
Option 3	BOMA BEST® Sustainable Buildings, version 3.0: Silver
Option 4	BOMA 360 Performance Program® for Office Buildings: Designation
Option 5	BREEAM® In-Use USA, version 2016: 2 star
Option 6	Living Building Challenge (LBCTM), version 3.1: Certification

Statutory Alignment:

The Guiding Principles and associated criteria include references to statutory and regulatory requirements, many of which are not specifically referenced in third-party certification systems. If an agency chooses to utilize a third-party system for the purposes of qualifying and reporting a building as a sustainable Federal building, it must also ensure that all building-level statutory and regulatory requirements are met.

GSA has developed resources to assist agencies in identifying specific credits within each third-party system that may align with meeting various statutory and regulatory requirements, as referenced in the Guidance. These GSA resources are provided for informational purposes; agencies remain responsible for ensuring that meeting the credits indicated also meet the relevant statutory and regulatory requirements. These additional resources can be found on GSA's SFTool: Guiding Principles for Sustainable Federal Buildings.

Appendix D

Assessing a Building Using the
Guiding Principles for Sustainable Federal Buildings

Reassessment Criteria Checklist

The Guiding Principles for Sustainable Federal Buildings Reassessment Criteria Checklist is a tool to evaluate whether a building previously identified as sustainable continues to meet the intent of the Guiding Principles. Agencies are to reassess buildings every four years using either the criteria in the table below, which aligns with the criteria in Appendix A and Appendix B, or by re-certification using a third-party system listed in Appendix C. Agencies are encouraged to streamline and incorporate applicable reassessment activities into campus management and operations plans, planned building EISA energy and water evaluations, and on-going building maintenance procedures.

Reassessing using Appendix D:

For buildings assessed using the 2016 or 2020 versions: Agencies should reevaluate all criteria used to initially qualify the building as meeting the Guiding Principles, and confirm that the building continues to meet all of the 12 core criteria applicable to the building and at least 50 percent (9 of 18) of the non-core criteria originally met and identified in this appendix. To accommodate changes to the building, agencies can "swap" non-core criteria, choosing non-core criteria not originally met.

For buildings assessed using the 2006 or 2008 versions*:* Agencies should reevaluate all criteria used to initially qualify the building as meeting the Guiding Principles, and confirm that the building continues to meet all of the 12 core criteria applicable to the building and as many of the non-core criteria identified in this appendix that are potentially relevant or applicable. There is no minimum number of non-core criteria that must be met.

In order to continue reporting a building as a sustainable Federal building, the agency should reassess the building as an existing building, using either the Reassessment checklist (Appendix D) or a third-party certification system (Appendix C) every four years. If upon reassessment the agency determines that the building's inherent function, mission, safety, or designation prevents it from meeting in a life cycle cost-effective manner the minimum thresholds outlined above, the building is no longer considered a high-performance sustainable Federal building because it does not meet the policy outlined in this Guidance. However, the agency can continue to report the building as a Federal high-performance building, so long it continues to meet all criteria that are life cycle cost-effective.

Reassessing using Third-Party Systems:
Agencies should maintain the certification using the third-party systems referenced in Appendix C, at the specified level or higher. Agencies should follow the certifying organization's protocols for re-certification as and when required by the organization. Agencies remain responsible for ensuring all buildings that were certified using third-party systems continue to comply with ongoing statutory requirements where they apply.

REFERENCE KEY

S	Criteria that are based on and reference statutory or regulatory requirements are indicated with "S" on the checklist. "S*" indicates an NDAA aligned criterion that is applicable to the Department of Defense (DoD).
Std	Criteria that are based on green building industry standards, rather than statutory or regulatory requirements, are indicated with "Std" on the checklist.
[C/I]	Criteria where campus-wide or installation-wide protocols, policies, contracts can be used to demonstrate, upon assessment, that the criteria were met at the building level are indicated on the checklist with a [C/I].

<table>
<tr><th colspan="5">1.0 - Employ Integrated Design Principles</th></tr>
<tr><td rowspan="2" colspan="2">Reassessment Criteria 1.1:</td><td rowspan="2">Integrated Design and Management</td><td colspan="2">CORE</td></tr>
<tr><td>(Std)</td><td></td></tr>
<tr><td colspan="5">Assess that the building's Operations and Maintenance procedures are in place and continue to be utilized. Ensure, as applicable, energy, water, materials, indoor environmental quality, recycling and composting, and occupant health and wellness continue to be utilized, as applicable to the building's function and mission.</td></tr>
<tr><td rowspan="2" colspan="2">Reassessment Criteria 1.2</td><td rowspan="2">Sustainable Siting</td><td colspan="2">NON-CORE</td></tr>
<tr><td>(S)</td><td>[C/I]</td></tr>
<tr><td colspan="5">Review building operations and ensure they continue to not adversely impact any natural resources on or adjacent to the site. Assess any relevant opportunities for enhancements to the site sustainability and continue to engage building occupants and implement any identified enhancements to optimize the site, as feasible and applicable. Where applicable, ensure that measures to enhance the sustainability of an historic property continue to be implemented in a manner that preserves the property's historic character.</td></tr>
<tr><td rowspan="2" colspan="2">Reassessment Criteria 1.3</td><td rowspan="2">Stormwater Management</td><td colspan="2">NON-CORE</td></tr>
<tr><td>(S)</td><td>[C/I]</td></tr>
<tr><td colspan="5">Confirm that the building, campus, or installation maintains strategies that reduce stormwater runoff and discharges offsite.</td></tr>
<tr><td rowspan="2" colspan="2">Reassessment Criteria 1.4</td><td rowspan="2">Infrastructure Utilization and Optimization</td><td colspan="2">NON-CORE</td></tr>
<tr><td>(Std)</td><td>[C/I]</td></tr>
<tr><td colspan="5">CHOOSE ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="4">Confirm that any utilized strategies, policies, or programs for encouraging public transit and alternative commuting remain in place, such as cycling, walkability, and transit incentives. If applicable, ensure parking for alternative fuel vehicles and alternative fueling stations or electric charging infrastructure are still accessible.</td></tr>
<tr><td>Option 2</td><td colspan="4">Ensure the building conforms to or exceeds 2018 IGCC Section 1001.3.2.4 (10.3.2.4) Transportation Management Plan and Section 501.3.7.3 (5.3.7.3) Site Vehicle Provisions.</td></tr>
<tr><td rowspan="2" colspan="2">Reassessment Criteria 1.5</td><td rowspan="2">Commissioning</td><td colspan="2">CORE</td></tr>
<tr><td>(S)</td><td></td></tr>
<tr><td colspan="5">CHOOSE ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="4">For a building identified as a "covered facility" (42 U.S.C. § 8253(f)(2)(B)): Ensure compliance with 42 U.S.C. § 8253(f)(3)(B) to identify and assess recommissioning measures for the facility, in accordance with U.S. Department of Energy's (DOE) Federal Energy Management Program's (FEMP) Commissioning for Federal Facilities guidance.</td></tr>
<tr><td>Option 2</td><td colspan="4">For a building not identified as a "covered facility" (42 U.S.C. § 8253(f)(2)(B)): assess the building for significant changes in building operations or building performance that would require recommissioning per agency policy, or follow FEMP's commissioning best practices. If changes occurred, perform recommissioning in accordance with FEMP's Commissioning for Federal Facilities guidance.</td></tr>
<tr><td>Option 3</td><td colspan="4">Perform ongoing commissioning in accordance with FEMP's Commissioning for Federal Facilities guidance. For covered facilities, ensure compliance with all statutory reporting requirements, per 42 U.S.C. § 8253(f)(3)(B), when using on-going commissioning.</td></tr>
</table>

2.0 Optimize Energy Performance

Reassessment Criteria 2.1	Energy Efficiency	CORE (S)

Confirm incorporation of energy-efficiency criteria consistent with statutory requirements for procurement of ENERGY STAR and FEMP-designated products.

Confirm incorporation of strategies to improve energy performance and reduce energy usage in accordance with 42 U.S.C. § 8253(a).

AND ONE OF THE FOLLOWING OPTIONS:

Option 1	Verify that the building energy use is 20 percent below a FY 2015 energy use baseline (from meter readings or engineering estimates). If baseline year data is not available or reliable, data from the earliest post-baseline year that is available and reliable may be used.
Option 2	Verify that the building energy use is 30 percent below a FY 2003 energy use baseline (from meter readings or engineering estimates). If baseline year data is not available or reliable, data from the earliest post-baseline year that is available and reliable may be used.
Option 3	Verify that the building has an ENERGY STAR score of 75 or higher.
Option 4	For building types not eligible to receive an ENERGY STAR score and where adequate benchmarking data exists, demonstrate that the building is in the top quartile of energy performance for its building type.
Option 5	Verify the building continues to comply with Federal design energy performance requirements established under 10 CFR parts 433, subpart A, and 10 CFR parts 435, subpart A, plus allowance for plug load to reflect actual use.

Reassessment Criteria 2.2	Energy Metering	CORE (S)

Where utilized, confirm that all appropriate standard and advanced meters are still in place and operating correctly based on application of DOE's *Federal Building Metering Guidance* per 42 U.S.C § 8253(e).

In a case where shared infrastructure for a facility is served by one meter, ensure the energy use of the building can still be tracked and evaluated using engineering energy estimates based on the size, function, and complexity of the building.

<table>
<tr><td colspan="2">Reassessment Criteria 2.3</td><td>Renewable Energy</td><td colspan="2">NON-CORE
(S) | [C/I]</td></tr>
<tr><td colspan="5">CHOOSE ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="4">Confirm any installed on-site renewable energy systems or alternative energy systems continue to operate as designed.</td></tr>
<tr><td>Option 2</td><td colspan="4">As provided for in section III.A.2 of the E.O. 13834 Implementing Instructions, if on-site renewable energy was not installed, ensure purchases of power from offsite renewable sources or renewable energy certificates (RECs) continue and are apportioned to the building, in alignment with agency plans.</td></tr>
<tr><td colspan="2">Reassessment Criteria 2.4</td><td>Benchmarking</td><td colspan="2">CORE
(S)</td></tr>
<tr><td colspan="5">CHOOSE ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="4">For a building identified as a “covered facility” (42 U.S.C. § 8253(f)(2)(B)):
Confirm annual benchmarking is occurring, preferably using ENERGY STAR Portfolio Manager, in accordance with DOE’s Federal Building Energy Use Benchmarking Guidance per 42 U.S.C. § 8253(f)(8).</td></tr>
<tr><td>Option 2</td><td colspan="4">For a building not identified as a “covered facility” (42 U.S.C. § 8253(f)(2)(B)):
Confirm the building continues to be benchmarked using a system consistent with agency policy, including alternative benchmarking systems and strategies not subject to public disclosure, if applicable.</td></tr>
<tr><td>Option 3</td><td colspan="4">Ensure the building still conforms to or exceeds 2018 IgCC Section 1001.3.2.1.3.2 (10.3.2.1.3.2) Track and Assess Energy Consumption, b. Track Energy Performance.</td></tr>
</table>

3.0 - Protect and Conserve Water			
Reassessment Criteria 3.1	**Indoor Water Use**	**CORE** (S)	
Confirm that strategies are employed to minimize water use and that policies and procedures are in place for purchase of water efficient products. Agencies should refer to EPA's WaterSense, GSA's SFTool - Water, and DOE-FEMP's Water Efficiency in Federal Buildings and Campuses resources for additional details on available water conservation technologies and best management practices.			
AND ONE OF THE FOLLOWING OPTIONS:			
Option 1	Verify that water use is 20 percent below a FY 2007 water use baseline (from meter readings or engineering estimates).		
Option 2	Verify analysis showing at least a 20 percent reduction when comparing installed fixture performance to a base case representing the code-minimum, using the FEMP Water Evaluation Data Tool or other fixture performance calculator.		
Option 3	Confirm or implement a strategic water management plan in accordance with FEMP's Best Management Practices (BMPs) for Water Efficiency.		
Reassessment Criteria 3.2	**Water Metering**	**NON-CORE** (Std)	
CHOOSE ONE OF THE FOLLOWING OPTIONS:			
Option 1	Where utilized, confirm that building-level meters are still in place and operational. In a case where shared infrastructure for a facility is served by one meter, ensure the water use of the building can still be tracked and evaluated using engineering energy estimates based on the size, function, and complexity of the building.		
Option 2	Ensure the building still conforms to or exceeds 2018 IgCC Section 601.3.4.1 (6.3.4.1) Consumption Management.		
Reassessment Criteria 3.3	**Outdoor Water Use**	**NON-CORE** (Std)	[C/I]
Confirm health and status of water efficient landscapes and replace where needed.			
AND ONE OF THE FOLLOWING OPTIONS:			
Option 1	Confirm irrigation system meters, where utilized, are still in place and operating correctly. Verify potable water use is still at or less than the planned amount.		
Option 2	Where xeriscaping techniques were used, confirm that no potable water is being used for irrigation, beyond re-establishment of lost plantings.		
Option 3	Ensure the building still conforms to 2018 IgCC Section 601.3.1.1 (6.3.1.1) Landscape Design. If irrigation is used, conform to Section 601.3.1.2 (6.3.1.2) Irrigation.		
Reassessment Criteria 3.4	**Alternative Water**	**NON-CORE** (Std)	[C/I]
CHOOSE ONE OF THE FOLLOWING OPTIONS:			
Option 1	Confirm that onsite alternative water systems continue to operate as designed.		
Option 2	Confirm continued use of alternative sources of water that conform to the 2018 IgCC Definitions of Water, Alternative on-site sources.		

<table>
<tr><th colspan="4">4.0 - Enhance the Indoor Environment</th></tr>
<tr><td rowspan="2">Reassessment Criteria 4.1</td><td rowspan="2">Ventilation and Thermal Comfort</td><td colspan="2">CORE</td></tr>
<tr><td>(S)</td><td></td></tr>
<tr><td colspan="4">Confirm indoor air quality remains consistent with the levels determined at the previous evaluation.

Ensure that actions are being taken to maintain or improve ventilation and thermal comfort, such as the collection of occupant feedback where feasible.</td></tr>
<tr><td rowspan="2">Reassessment Criteria 4.2</td><td rowspan="2">Daylighting and Lighting Controls</td><td colspan="2">NON-CORE</td></tr>
<tr><td>(S)</td><td></td></tr>
<tr><td colspan="4">Confirm all minimum illumination levels, lighting controls, daylighting, and glare control devices are operating correctly, based on occupant feedback or evaluations.

Ensure any circadian-effective lighting installed is still in operation and utilized.</td></tr>
<tr><td rowspan="2">Reassessment Criteria 4.3</td><td rowspan="2">Low-Emitting Materials and Products</td><td colspan="2">NON-CORE</td></tr>
<tr><td>(Std)</td><td>[C/I]</td></tr>
<tr><td colspan="4">Confirm the building continues to comply with all policies and procedures to utilize low-emitting materials and products.</td></tr>
<tr><td rowspan="2">Reassessment Criteria 4.4</td><td rowspan="2">Radon Mitigation</td><td colspan="2">NON-CORE</td></tr>
<tr><td>(S)</td><td></td></tr>
<tr><td colspan="4">Confirm all radon mitigation equipment and measures utilized are still in place and operational.

No action needed if not utilized or no elevated radon was detected.</td></tr>
<tr><td rowspan="2">Reassessment Criteria 4.5</td><td rowspan="2">Moisture and Mold Control</td><td colspan="2">NON-CORE</td></tr>
<tr><td>(Std)</td><td></td></tr>
<tr><td colspan="4">Confirm that a moisture control and mitigation strategy is still in place for controlling moisture flows and condensation to prevent building damage, minimizing mold contamination, and reducing health risks related to moisture.</td></tr>
<tr><td rowspan="2">Reassessment Criteria 4.6</td><td rowspan="2">Indoor Air Quality during Construction</td><td colspan="2">NON-CORE</td></tr>
<tr><td>(Std)</td><td></td></tr>
<tr><td colspan="4">No action required for reassessment</td></tr>
<tr><td rowspan="2">Reassessment Criteria 4.7</td><td rowspan="2">Environmental Smoking Control</td><td colspan="2">CORE</td></tr>
<tr><td>(S)</td><td>[C/I]</td></tr>
<tr><td colspan="4">CHOOSE ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="3">Confirm that smoking in any form continues to be prohibited inside and within 25 feet of all building entrances, operable windows, and building ventilation intakes. Confirm that signage is still installed as appropriate.</td></tr>
<tr><td>Option 2</td><td colspan="3">Ensure the building still conforms to or exceeds 2018 IgCC Section 801.3.1.7 (8.3.1.7) Environmental Tobacco Smoke.</td></tr>
</table>

<table>
<tr><td rowspan="2">Reassessment Criteria 4.8</td><td rowspan="2">Integrated Pest Management</td><td colspan="2">NON-CORE</td></tr>
<tr><td>(S)</td><td>[C/I]</td></tr>
<tr><td colspan="4">Confirm all building or campus/installation-level integrated pest management (IPM) practices are still in use, as applicable. Refer to GSA’s IPM definition, EPA’s IPM resources, and GSA’s SFTool Pest Management resources for additional program guidance.</td></tr>
</table>

<table>
<tr><td rowspan="2">Reassessment Criteria 4.9</td><td rowspan="2">Occupant Health and Wellness</td><td colspan="2">NON-CORE</td></tr>
<tr><td>(Std)</td><td></td></tr>
<tr><td colspan="4">CHOOSE ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="3">Confirm health and wellness opportunities provided to occupants are still accessible and operational.

Incorporate, as applicable, feedback from occupants on needed updates or revisions to health and wellness opportunities. Agencies can and are encouraged to re-evaluate opportunities and add or change as needed. Agencies should refer to GSA’s SFTool: Buildings and Health for additional strategies and guidance on health and wellness in Federal facilities.</td></tr>
<tr><td>Option 2</td><td colspan="3">Confirm that any previously obtained certification from a Health & Wellness Standard and Rating System identified by GSA is maintained and the building continues to follow ongoing requirements.</td></tr>
</table>

<table>
<tr><th colspan="5">5.0 - Reduce the Environmental Impact of Materials</th></tr>
<tr><td colspan="2" rowspan="2">Reassessment Criteria 5.1</td><td rowspan="2">Materials - Recycled Content</td><td colspan="2">CORE</td></tr>
<tr><td>(S)</td><td>[C/I]</td></tr>
<tr><td colspan="5">Confirm a product purchasing policy or procedures covering recycled content are still in place. Evaluate product procurement and identify opportunities for improvement, if applicable.</td></tr>
<tr><td colspan="2" rowspan="2">Reassessment Criteria 5.2</td><td rowspan="2">Materials - Biobased Content</td><td colspan="2">CORE</td></tr>
<tr><td>(S)</td><td>[C/I]</td></tr>
<tr><td colspan="5">Confirm a product purchasing policy or procedures covering biobased content are still in place. Evaluate product procurement and identify opportunities for improvement, if applicable.</td></tr>
<tr><td colspan="2" rowspan="2">Reassessment Criteria 5.3</td><td rowspan="2">Products</td><td colspan="2">NON-CORE</td></tr>
<tr><td>(Std)</td><td>[C/I]</td></tr>
<tr><td colspan="5">Confirm a product purchasing policy or procedures covering relevant EPA-recommended products are still in place. Evaluate product procurement and identify opportunities for improvement, if applicable.</td></tr>
<tr><td colspan="2" rowspan="2">Reassessment Criteria 5.4</td><td rowspan="2">Ozone Depleting Substances</td><td colspan="2">CORE</td></tr>
<tr><td>(S)</td><td>[C/I]</td></tr>
<tr><td colspan="5">CHOOSE ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="4">Confirm a product purchasing policy or procedures are in place to ensure compliance. Evaluate product procurement and identify opportunities for improvement, if applicable.</td></tr>
<tr><td>Option 2</td><td colspan="4">Ensure building still conforms to or exceeds IgCC Section 901.3.3 (9.3.3) Refrigerants.</td></tr>
<tr><td colspan="2" rowspan="2">Reassessment Criteria 5.5</td><td rowspan="2">Hazardous Waste</td><td colspan="2">CORE</td></tr>
<tr><td>(S)</td><td></td></tr>
<tr><td colspan="5">Confirm that building-level or campus/installation-level programs or procedures are still in place to ensure compliance with all relevant hazardous waste requirements.</td></tr>
<tr><td colspan="2" rowspan="2">Reassessment Criteria 5.6</td><td rowspan="2">Solid Waste Management</td><td colspan="2">NON-CORE</td></tr>
<tr><td>(Std)</td><td>[C/I]</td></tr>
<tr><td colspan="5">Confirm that a waste management and recycling policy, program, or procedures are in place.</td></tr>
<tr><td colspan="5">CHOOSE ONE OF THE FOLLOWING OPTIONS:</td></tr>
<tr><td>Option 1</td><td colspan="4">Verify waste diversion rate continues to meet or exceed original planned levels of diversion, taking into account any changes in mission, building function, or recycling markets.</td></tr>
<tr><td>Option 2</td><td colspan="4">Conduct an analysis of non-hazardous non-construction waste and develop or update an existing waste management plan or industry equivalent to increase waste diversion rate.</td></tr>
</table>

6.0 - Assess and Consider Building Resilience			
Reassessment Criteria 6.1	**Risk Assessment**	**NON-CORE**	
		S*	**[C/I]**
CHOOSE ONE OF THE FOLLOWING OPTIONS:			
Option 1	Confirm whether there have been changes to long-term mission criticality of the physical asset and operations to be housed in the facility. Where applicable, evaluate if those changes impact any results from the original risk assessment. Ensure updates to relevant predicted impacts are incorporated, and adjust plans as necessary based on mission criticality and cost.		
Option 2	Confirm that the building, as well as any planned mission critical activities housed in the building, have been evaluated and integrated as part of a recent agency, facility, installation, or campus resilience or adaptation assessment. This can include any other resilience and adaptation assessment activities associated with Installation Master Plans, climate adaptation plans, or equivalent agency, installation, or campus resilience or adaptation plans.		
Reassessment Criteria 6.2	**Building Resilience and Adaptation**	**NON-CORE**	
		S*	**[C/I]**
CHOOSE ONE OF THE FOLLOWING OPTIONS:			
Option 1	Confirm and monitor implemented resilience measures and systems to assess effectiveness of planned climate resilience strategies.		
Option 2	Continue to implement or verify past implementation of applicable cost-effective strategies identified through an agency developed resilience or adaptation plan or any other Federal agency developed climate resilience or risk assessment planning tools. (For examples of available tools, refer to criteria 6.1 in Appendix A or B.)		

Appendix E

Sustainable Federal Buildings Reporting Instructions

Reporting:
Agencies must report annually on sustainable Federal building status in GSA's real property database, the Federal Real Property Profile Management System (FRPP MS), pursuant to 40 U.S.C. § 524(a)(11)(B)(vii). **Detailed instructions are issued annually by GSA in the FRPP MS Data Dictionary.** Agencies should report buildings that meet the minimum criteria outlined in the *Guiding Principles for Sustainable Federal Buildings and Associated Instructions* as sustainable (YES) in the FRPP. To assist agencies in tracking progress metrics on sustainable Federal buildings and project future progress based on planned or expected changes to the building portfolios, agencies can utilize DOE-FEMP's Federal Sustainable Buildings Progress Calculator tool.

Assessment Pathways:
Agencies may qualify buildings, including new construction, modernization projects, and existing buildings, as meeting the Guiding Principles using one of the following: 1. Guiding Principles for Sustainable Federal Buildings Checklist (see Appendices A, B, and D). 2. Third-party building certifications systems or standards identified by GSA's Office of Federal High-Performance Buildings (see Appendix C).
Applicability:
Agencies must report sustainability status if the building meets the following conditions: • Federally owned; • Equal to or greater than 10,000 gross square feet (GSF); • Located in the United States or its territories; and • Legal interest of owned (G) or museum trust (M).

Not Applicable Buildings:
A building is considered **NOT APPLICABLE (N/A)** for the purposes of FRPP reporting of sustainable Federal buildings if it meets **any** of the following conditions:
• Non-building asset; • Located outside the United States or its territories; or • Slated for disposal (as a status indicator of report of excess (ROE) submitted, ROE accepted, Determination to Dispose, or Surplus).
Or it meets **all** of the following conditions:
• Unoccupied: The building is occupied one hour or less per person per day on average; • Low/No Energy Use: Total energy consumption from all sources is less than 12.7 kBtu/GSF/year; and • Low/No Water Use: Water consumption is less than two gallons per day on average.

Appendix F

Definitions

Alternative Water	Alternative water is water from non-freshwater sources, such as on-site harvested rainwater and stormwater, harvested sump pump/foundation water, gray water, air-cooling condensate, reject water from water purification systems, reclaimed wastewater, or water derived from other water reuse strategies. E.O. 13834 Implementing Instructions.
ASHRAE	A global professional society focused on building systems, energy efficiency, indoor air quality, refrigeration, and sustainability within the building industry through research, standards writing, publishing, and continuing education. ASHRAE was formed as the American Society of Heating, Refrigerating and Air-Conditioning Engineers by the merger in 1959 of American Society of Heating and Air-Conditioning Engineers (ASHAE) and The American Society of Refrigerating Engineers (ASRE). *See* ASHRAE, About.
Basis of Design (BOD)	Documentation of the major thought processes and assumptions behind design decisions based on the owner's project requirements. Can be the primary document that translates the agency's needs into building components such as heating ventilating and air conditioning (HVAC) systems, building envelope, security systems, or building automation system; or, a document that records the concepts, calculations, decisions, and product selections used to meet the owner's project requirements and to satisfy applicable regulatory requirements, standards, and guidelines. The BOD includes both narrative descriptions and lists of individual items that support the design process. *See* U.S. General Services Administration, Review Owner Project Requirements and Basis of Design.
Biophilia / Biophilic Design	Biophilia addresses the human attraction to and desire to be in environments that have natural features including parks, gardens, street trees, bird feeders, flowers, big sky, and water elements. *See* U.S. General Services Administration, SFTool: Biophilia.
Building Automation System (BAS)	An automatic control of a building's HVAC, lighting, and other systems through a centralized building management system. *See* U.S. General Services Administration, 5.22 Building Automation Systems (BAS).
Charrette	A collaborative planning or design session in which problems relating to a proposed project are discussed and solutions adopted in a limited time frame; or, an intensive workshop in which various stakeholders and experts are brought together to address a particular design issue. *See* National Institute of Building Sciences, Whole Building Design Guide: Planning and Conducting Integrated Design (ID) Charrettes.
Commissioning (Retro and Re-commissioning)	Systematic, quality assurance processes used in new construction or in existing buildings to verify that a building's operating systems—mechanical, electrical, and HVAC—are designed, installed, and programmed for optimal performance or maintained and improved to enhance overall building performance. *See* U.S. Department of Energy Federal Energy Management Program (FEMP): Commissioning in Federal Buildings.
Conceptual Design Report (CDR)	A document summarizing the concept of the proposed building design goals and mission objectives. See U.S. Department of Energy, Directives Program: Conceptual Design Report.
Energy Modeling	Whole building simulation tool to model energy performance for new building design, using the Performance Rating Method found in Appendix G of ANSI/ASHRAE/IES Standard 90.1. *See* U.S. Department of Energy, About Building Energy Modeling.

Federal Building	A building (including a complete replacement of an existing building from the foundation up) to be constructed by, or for the use of, any Federal agency, including a building leased by a Federal agency and privatized military housing. 42 U.S.C. § 6832(6).
Federal Facility	Any building, installation, structure, or other property (including any applicable fixtures) owned or operated by, or constructed or manufactured and leased to, the Federal Government. The term “facility” includes a group of facilities at a single location or multiple locations managed as an integrated operation and contractor-operated facilities owned by the Federal Government. The term “facility” does not include any land or site for which the cost of utilities is not paid by the Federal Government. 42 U.S.C. § 8253
Green Building Certification System	A type of building certification system that rates or rewards relative levels of compliance or performance with specific environmental goals and requirements. Rating systems and certification systems are frequently used interchangeably. Green building rating and certification systems require an integrated design process to create projects that are environmentally responsible and resource-efficient throughout a building's life-cycle: from siting to design, construction, operation, maintenance, renovation, and demolition. *See* National Institute of Building Sciences, Whole Building Design Guide: Introduction.
High-Performance Building	A building that integrates and optimizes on a life cycle basis all major high performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations. 42 U.S.C. § 17061(12)
High-Performance Green Building	A high-performance building that, during its life-cycle, as compared with similar buildings (as measured by Commercial Buildings Energy Consumption Survey or Residential Energy Consumption Survey data from the Energy Information Agency)— (A) reduces energy, water, and material resource use; (B) improves indoor environmental quality, including reducing indoor pollution, improving thermal comfort, and improving lighting and acoustic environments that affect occupant health and productivity; (C) reduces negative impacts on the environment throughout the life-cycle of the building, including air and water pollution and waste generation; (D) increases the use of environmentally preferable products, including biobased, recycled content, and nontoxic products with lower life-cycle impacts; (E) increases reuse and recycling opportunities; (F) integrates systems in the building; (G) reduces the environmental and energy impacts of transportation through building location and site design that support a full range of transportation choices for users of the building; and (H) considers indoor and outdoor effects of the building on human health and the environment, including— (i) improvements in worker productivity; (ii) the life-cycle impacts of building materials and operations; and (iii) other factors that the Federal Director or the Commercial Director consider to be appropriate. 42 U.S.C. § 17061(13)
Historic property	Any prehistoric or historic district, site, building, structure, or object included on, or eligible for inclusion on, the National Register [of Historic Places], including artifacts, records, and material remains relating to the district, site, building, structure, or object. 54 U.S.C. § 300308

HVAC&R systems	Heating, ventilation, air conditioning, and refrigeration systems. *See* National Institute of Building Sciences, Whole Building Design Guide: Heating, Ventilating, Air-Conditioning, and Refrigerating Engineering.
Integrated Pest Management (IPM)	A coordinated system of technological and management practices to control pests in a safe, environmentally sound, and economical manner. It is a process for minimizing pesticide use and risk while maximizing the control of pests that affect public health, impede operations, or damage property. *See* U.S. General Services Administration, Integrated Pest Management.
International Green Construction Code (IgCC)	A model code to incorporate sustainability measures for a construction project and its site. It includes the technical requirements of ANSI/ASHRAE/ICC/USGBC/IES Standard 189.1, Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings. *See* International Green Construction Code.
Life Cycle Cost	The total cost of owning, operating and maintaining a building over its useful life (including its fuel and water, energy, labor, and replacement components), determined on the basis of a systematic evaluation and comparison of alternative building systems, except that in the case of leased buildings, the life cycle cost shall be calculated over the effective remaining term of the lease. 10 CFR 436.11. Procedures for the analysis and comparison of lifecycle cost is set out in subpart A of 10 CFR Part 436.
Modernization	The comprehensive replacement or restoration of virtually all major systems, interior finishes (such as ceilings, partitions, doors, and floor finishes), and building features. *See generally* U.S. General Services Administration, 8.5 Existing Construction Modernization.
New Federal Building	A building to be constructed on a site that previously did not have a building or a complete replacement of an existing building from the foundation up, by, or for the use of, any Federal agency which is not legally subject to State or local building codes or similar requirements. 10 CFR § 433.2
Owner's Project Requirements (OPR)	Documentation of requirements and expectations of how a building will function, including project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting documentation to meet the designated purpose and mission. *See* U.S. General Services Administration, Define Owner's Project Requirements with the Customer Agency.
Renewable Energy Certificates (RECs)	Market-based instruments that represent the property rights to the environmental, social and other non-power attributes of renewable electricity generation. RECs represent the environmental attributes of one megawatt-hour (MWh) of electricity generated and delivered to the electricity grid from a renewable energy resource. *See* U.S. Environmental Protection Agency, Green Power Partnership: Renewable Energy Certificates (RECs).
Renovation	For the purposes of this guidance, renovations are any project or activity that does not meet the definition of "modernization."
Xeriscaping	A low-water landscaping practice that focuses on using native plants and little or no irrigation. *See* U.S. Environmental Protection Agency, Water-Smart Landscapes.

SECTION 01 82 00 – STRUCTURAL

PART 1 - PROJECT REQUIREMENTS

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

PART 2 - CODES AND STANDARDS

2.1 DESIGN STANDARDS

A. Work Smart Standards referenced in Section 01 41 00 apply to this Section.

B. Additional Codes & Standards.
1. 29 CFR 1910 Subpart D, Walk – Working Surfaces.
2. 29 CFR 1926 Subpart M, Fall Protection.
3. ANSI A14.3-2008, American National Standard for Ladders – Fixed - Safety Requirements.
4. ANSI/ASSE Z359.6-2009, Specifications and Design Requirements for Active Fall Protection Systems.
5. American Society of Civil Engineers (ASCE) ASCE 7-10, Minimum Design Loads for Buildings and Other Structures.
6. DOE STD-1020-2016, Natural Phenomena Hazards Design & Evaluation Criteria for DOE Facilities.
7. Metal Building Manufacturers Association (MBMA), Metal Building Systems Manual.

PART 3 - TECHNICAL REQUIREMENTS

3.1 GENERAL

A. For facilities other than Hazard Category 1, 2, and 3 Nuclear Facilities, the structural design will fulfill the requirements of DOE O-420.1C and DOE-STD-1020 by complying with the ASCE 7 with the following requirements listed below:
1. Wind loads shall be determined using Risk Category II, a basic wind speed of 115 mph, Exposure Group B, and an Importance Factor 1.0.
2. Earthquake loads shall be determined using Risk Category II and Importance Factor 1.0.
3. All structural drawings, specifications, and calculations shall be sealed by a PE licensed in the State of Tennessee.

4. Roofs shall be designed for the loads prescribed in paragraph 3.3 of this criteria section, except the minimum roof live load shall be 20 psf (non-reducible), and there shall also be an additional 5 psf collateral load.
5. Floor areas that will serve as corridors for the movement of equipment shall have a minimum live load capacity equal to the largest live load of any room to which they are connected.

3.2 STRUCTURAL SYSTEMS

A. General.
1. A description of the structural systems, including the lateral force resisting system, geotechnical parameters, design loads, site class, and seismic design category shall be summarized on the design drawings and any design assumptions.
2. Any structural feature requiring concrete shall contain a minimum of 20% flyash in the mix, unless performance requirements dictate otherwise.
3. Walls used to support equipment; cabinetry, etc. shall be designed to safely carry all imposed loads.

B. Foundations.
1. The building's foundations shall be designed to support all design loads within the allowable soil parameters defined in the Geotechnical Report.
2. Field testing shall be performed during construction to verify that actual bearing pressure capacities meet or exceed the design values.
3. Provide waterproofing for all below grade exterior walls and water stops in all construction joints.
   a. Structures with basements shall evaluate the site conditions for the need for a radon removal system in accordance EPA/625/R-92/016 June 1994 – Radon Prevention in the Design and Construction of Schools and Other Large Buildings.

C. Floors - Floor systems shall be designed to carry the intended loads and meet the following provisions:
1. Design of concrete slabs on grade shall utilize the subsurface soil parameters defined the Geotechnical Report. Minimum concrete strength shall be 4000 psi.
2. All concrete floors shall be sealed after initial placement of slab to prevent dusting.
3. All concrete floors to remain exposed and are not scheduled to receive epoxy finish or similar floor treatment shall have a second coat of sealer applied at project completion prior to beneficial occupancy. Slab shall be thoroughly cleaned prior to application of sealer.
4. Provide sealant or filler at all concrete slab joints.
5. Concrete floor slab flatness and levelness shall be F_F 25 and tested in accordance with ASTM E1155, as required. Remedial action shall be required by the Seller at no cost to the Company if measured F numbers are less than those specified.
6. For slabs on grade where a vapor barrier is required, a 3 inch sand layer shall be specified between the vapor barrier and slab.
7. Elevated floor systems shall be designed to avoid resonant vibration due to human activity (reference AISC Design Guide 11: Floor Vibrations Due to Human Activity).

D. Roofs.

1. Secondary (overflow) drainage shall be provided.
2. The roof system shall be designed to support the maximum depth of ponded water assuming the primary drainage system is blocked.

E. Prefabricated Buildings.
1. Design of the prefabricated building system shall be the responsibility of the building manufacturer.
2. The design and installation of the prefabricated building system shall comply with the MBMA Metal Building Systems manual, and this design criteria.
3. Cables are not permitted as vertical or horizontal bracing.

F. Precast Concrete.
1. The precast concrete plant shall be certified by the Precast/Prestressed Concrete Institute's (PCI) Plant Certification Program prior to the start of production.
2. Manufacturing procedures and tolerances shall comply with PCI MNL-116, Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.
3. Exposed surfaces shall be free of form lines and other surface blemishes. Inspection and acceptance of the first production units will be required before delivery.

3.3 EQUIPMENT SUPPORTS

A. Seismic design of equipment supports and anchorage shall be in accordance with IBC 2012.

3.4 FALL PROTECTION

A. Fall protection systems shall comply with the requirements of ANSI/ASSE Z359.2 and 29 CFR 1926 Subpart M (where differences occur, the most conservative requirements shall be followed). System components and materials shall comply with ANSI, ASME, or ASTM standards or requirements, as applicable.

3.5 FIXED LADDERS INCLUDING EQUIPMENT ACCESS LADDERS

A. The design of fixed ladders shall comply with ANSI A14.3, 29 CFR 1910.23, 29 CFR 1910.28, and ASCE 7-10. Contact the Company with any conflicting requirements.

B. The design of elevator pit ladders shall comply with ASME A17.1.

C. The design of precast reinforced concrete circular manhole sections shall comply with ASTM C478.

END OF SECTION 01 82 00

SECTION 01 83 00 – ARCHITECTURAL

PART 1 - PROJECT REQUIREMENTS

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. The architectural style, material and color palette and configuration shall be consistent with the existing facility and shall be subject to approval of the Company.

B. Materials and systems defined in this section shall be considered the minimum requirements are subject to meeting the performance requirements of the research equipment identified in section 01 10 00 Summary of Work. And design of a facility that provides the environmental stability as high as reasonably achievable to accommodate the new electron microscopes and optimize microscope performance.

C. Rooftop mechanical will not be permitted without approval of the company, but if required, shall be screened from view with a screen or penthouse of compatible material matching the building exteriors. Personnel access to all areas outside of the screen is required. All areas requiring routine maintenance shall be provided with a minimum 42” high fall protection barrier of material and design to match the building exteriors. Items such as roof drains and other items that do not require routine maintenance shall be provided with fall protection lifeline anchor points as a minimum.

D. All exterior entry doors at main entries shall be provided with double sets of doors and vestibules shall be provided to minimize impact on indoor air comfort. A cover shall be provided over all doors for main entries. A primary card reader for entry to the building shall be provided inside the vestibule area, controlling the interior set of doors. A secondary card reader is required under cover at the exterior of the vestibule. The secondary card reader will activate operators to open one leaf of each set of entry doors for ADA access to the building. The secondary

E. The building design shall promote interaction between occupants within the building and from other areas near the site.

F. Daylighting shall be maximized to the extent practical.

G. Space Requirements shall be as required to accommodate the research equipment and building support equipment. The size volume and configuration of each room shall be optimized for the specific use as required by the research and building support equipment.

PART 2 - CODES AND STANDARDS

2.1 STANDARDS

A. Work Smart Standards referenced in Section 01 41 00 apply to this Section.

B. Additional Standards.
1. “Managing the Risk of Mold in the Construction of Buildings” developed by the Mold Litigation Task Force of the Associated General Contractors of America., Inc.
2. United States Green Building Council’s USGBC) Leadership in Environmental and Energy Design (LEED).
3. High Performance Sustainable Building (HPSB) Guiding Principles.

C. References
1. See Section 01 86 13, Fire Protection, for building classifications.

D. Engineering Standards
1. ORNL F&O Interior Finish Standards - See Section 01 84 19

PART 3 - TECHNICAL REQUIREMENTS

3.1 MATERIAL REQUIREMENTS

A. Materials Restrictions.
1. Materials or components containing asbestos, polychlorinated biphenyl (PCB), CFCs, HCFCs, lead, and carcinogens shall not be utilized in any portion of the design or construction.
2. Wood material shall not be used for any part of building construction with the exception of fire-retardant, UL listed plywood, which is permitted in the telecommunications rooms for telephone and computer terminal boards only and wood for roof flashing attachment. Wood doors may also be used, but they must comply with fire code requirements.
3. Zinc hardware/material shall not be utilized.
4. Zinc chromate paint shall not be utilized.
5. Class I refrigerants shall not be utilized.
6. See LEED requirements when seeking USGBC’s LEED certification.

B. General Materials Selection.
1. As part of the Master Plan for ORNL, a schematic architectural vocabulary and direction has been established to assure that the master planning principles are expressed in architectural form. The intention of this section is to provide insight and direction to the architectural development of the campus. Elaborations and extensions of these ideas and expressions, or their creative equivalents, shall be integrated into the architectural and site design strategies for the facility. They shall include the following:
   a. The creation of an open research campus, which reflects in physical form the history, transitions, ideals, and identify ORNL.

b. The use of sustainability as a major organizing design principle for buildings and landscape.
c. The creation of a flexible yet coherent site and building structure that allows for growth and change.

2. Use sustainable materials and design principles identified in Section 01 81 13, Energy and Sustainability.
3. The design, materials and systems of a building shall follow the practices contained in "Managing the Risk of Mold in the Construction of Buildings" developed by the Mold Litigation Task Force of the Associated General Contractors of America., Inc.

C. Exterior Building Materials.

1. General.
    a. Exterior material and color palate shall be approved by ORNL.
    b. The design intent shall be to construct the addition using materials that are consistent with the color palette and character of the existing facility.
2. Exterior wall materials.
    a. Masonry and Stone.
        1) Standard Brick.
            a) East Campus – Building 7120 brick or ORNL approved materials of compatible color and texture.
            b) Central Campus – Buildings 4100, 5100, 5300 brick and precast or ORNL approved materials of compatible color and texture.
            c) West Campus – Building 1520 brick and precast/cast stone or ORNL approved materials of compatible color and texture.
        2) Provide continuous thru wall flashing at the bottom of all wall cavities and over all openings and stone copings. Maintain minimum clear airspace of 1", exclusive of cavity insulation, for drainage within wall cavity to weep holes.
        3) Use ties that are a minimum of 3/8" thick and that allow movement to prevent cracking in the facing. Galvanized corrugated metal strap ties are not acceptable.
        4) A mock-up (4'-0" by 8'-0" as a minimum) shall be provided for each type of specified materials and shall be reviewed and accepted by the Company prior to commencement of the work demonstrated. Mock-up should demonstrate outside corner, inside corner, cap, and joinery range and workmanship.
    b. Metal Panels.
        1) The use of metal panels requires acceptance by the Company.
        2) Standard Metal panel colors.
            a) East Campus – only as approved by the Company.
            b) Central Campus – only as approved by the Company.
            c) West Campus – only as approved by the Company.
            d) 7600 Area – Galvalume (no color).
        3) Metal panels shall be of heavy enough gage, or with adhered backing, that will not present "oil canning" of the finish surface.
        4) Air infiltration may not exceed the recommended limits established by NAAMM Standard TM-1.
    c. Pre-cast Concrete.

1) Panels shall contain either coal fly ash and/or ground granulated blast furnace slag, unless performance requirements cannot be met using these materials.
2) Layout of panels and joints and detailing shall be simple and as repetitive as practical. Align joints horizontally and vertically with architectural elements, such as wall openings, floor levels, etc.
3) See Section 01 82 00, Structural, for additional requirements.

d. Poured-in-place concrete.
1) See requirements of Section 01 82 00, Structural.

e. Exterior Finish and Insulation System (EIFS).
1) Install according to the EIFS Industry Manufacturers' Association (EIMA) guidelines.
2) Minimum thickness of foam backing to be 2".
3) Use heavy duty facing materials to prevent denting.

3. Windows storefronts.
a. Aluminum storefront system and glazing color shall match the existing window or storefront system.
b. Glazing shall be high performance thermal pane glazing units installed in a thermally broken frame. Designer to determine the "U" values and shading coefficients to provide the most energy efficient units.
c. Maximum window, glass, and/or day lighting in areas of personnel occupancy is desirable contingent on room use and function.
d. Glazing methods and materials shall comply with the Flat Glass Marketing Association's (FGMA) Glazing Manual and Sealant Manual. Float glass shall comply with ASTM C1036-01.

4. Exterior doors.
a. Exterior doors shall be a minimum of 3'-0" by 7'-0".
b. Exterior doors shall be insulated.
c. Material of main entry doors shall match existing entry doors type and material
d. Hollow metal doors shall be constructed in accordance with the Steel Door Institute (SDI) standard SDI-100, unless otherwise noted.
e. Exterior hollow metal doors shall have a minimum of 16-gage, flush-face panel, welded construction. Exterior hollow metal frames shall be a minimum 2", 14-gage, welded construction and ground smooth.
f. Provide a minimum of three hinges for each leaf, unless top and bottom pivot hinges are specified.
g. Provide a minimum of three anchors for each jamb.
h. Main entryways shall have airlocks and protection from weather (overhangs or canopies).
i. Refer to Section 01 86 33, Security, for security hardware requirements. All locksets, including dead bolts and exit devices, shall receive Best 7-pin A series lock cores, for master keying by the Company. Exterior locksets shall be mortised type construction.
j. See Section 01 86 33, Security, for proximity card readers and lock sets.

5. Roofing systems.
a. General.
1) Roofing system shall be a cool roof as follows:
a) Low-sloped roof (pitch of less than or equal to 2:12) must be designed and installed with a minimum of 3-year aged solar

reflectance of 0.55 and a minimum of 3-year aged thermal emittance of 0.75 in accordance with the Cool Roof Rating Council Program http://www.coolroofs.org or with a minimum of 3-year aged solar reflectance index (SRI) of 64 in accordance with the ASTM Standard E1980-01.

2) Specify roofing systems with a minimum 20-year warranty, unless noted otherwise.
3) Provide roofing systems that comply with Energy Star rating requirements, and labeled, and having emissivity of at least 0.9 when tested in accordance with ASTM 408.
4) Roofing system shall meet or exceed UL Class A fire exposure requirements.
5) Roofing system shall comply with FM Class 1-90 for wind uplift, per ASTM 1592. Tests utilizing UL 580 are not acceptable.
6) Design roof systems to ensure that the dew point does not occur within the roof system. See Managing the Risk of Mold in the Construction of Buildings.
7) Roof construction details shall comply with the National Roofing Contractors Association (NRCA) Roofing and Waterproofing Manual, and the Sheet Metal and Air Conditioning Contractors National Association’s (SMACNA) Architectural Sheet Metal Manual.
8) Roof details for coping and flashing shall clearly depict lap of roof membrane(s) and metal flashing or other materials to clearly demonstrate the intent of achieving a weather tight condition.
9) Equipment curb flashing details shall allow for the roof membrane/material thickness so the base of roof top equipment installed on curbs does not pitch, stress or bind roof material/membrane.
10) Provide permanent fall protection anchors for all roof areas spaced to comply with OSHA requirements.
11) Where roof drainage is directed toward the uphill side of the building, downspouts shall be connected to underground rain-water leaders that direct the flow to the downhill side of the building.
12) Provide splash block at the bottom of all downspouts that spill directly to grade or the roof below.
13) Roof drains shall be a minimum of 4” diameter. Provide a minimum of two drains for any single roof area or on either side of an expansion joint.
14) Once roof system is installed, no work shall be performed using the roof as a “work area/platform” without written acceptance by the Company. The seller shall protect the roof for the length of the project. Roof shall be in like new condition at project final completion.

b. Modified bitumen roofing systems.
1) Roofing with Energy Star coating.
2) Minimum slope shall be ¼” per foot.
3) Provide a minimum cap sheet thickness of 115 mils.
4) Modified bitumen roofing system shall be a minimum of 3-ply.
5) Reinforce with at least one mat of 100 mil minimum polyester base sheet.
6) Provide traffic pads of recycled rubber from roof access points to, and around, roof mounted equipment such as cooling towers, HVAC equipment,

satellite dishes, etc. If heavy traffic is expected, or if the roof is a public assess area, concrete pavers should be used.

c. Single-ply roofing systems.
   1) Energy Star rating.
   2) Minimum slope shall be ¼” per foot.
   3) Single-ply roofs are not allowed in areas where roof traffic is expected to be moderate or heavy, such as, to service roof top equipment.
   4) Follow guidelines set forth by the Single Ply Roofing Institute and National Roofing Contractors Association.
   5) Membrane shall be polyester reinforced, 45 mils minimum thickness.
   6) Provide surface membrane meeting requirements of Energy Star.
   7) Thermo polyolefin (TPO) roofing systems are not acceptable.

6. Thermal and moisture protection.
   a. Flashing and sheet metal.
      1) Provide flashing as a positive water stop around all openings (head, jamb, and sill) in walls such as windows, doors, louvers, etc.
      2) Provide scuppers for all roofs with a cross sectional area equal to that of the designed roof leader system. Slope scuppers slightly to the exterior and extend a minimum of 3” from the face of the wall to provide a positive drip.
      3) Interior built-in gutters shall be avoided.
      4) All coping and gravel stops shall be ES-1 compliant as required by the IBC.
      5) All flashing and sheet metal shall be detailed in accordance with SMACNA plates.
   b. Damp-proofing.
      1) Vapor barriers shall be provided in accordance with the IBC and ASHRAE Fundamentals Handbook.
      2) Damp-proofing of concrete shall comply with ACI Guide to the Use of Waterproofing, Damp-proofing, Protective and Decorative Barrier Systems for Concrete.
      3) Damp-proofing of concrete masonry shall comply with National Concrete Masonry Association (NCMA) Waterproof Coatings for Concrete Masonry and Concrete Masonry Basements and Earth-Sheltered Structures.
      4) Damp-proof walls, floors, and other building elements that at any time are subject to high humidity, dampness, or frequent direct water contact, but are not subject to hydrostatic pressure, are not below the water table, or are not immersed in water, including the outer face of block back-up walls for brick. Also, damp-proof on the damp side of shower rooms, cold storage areas, built-in refrigerators and freezers, and areas using water wash-down.
   c. Waterproofing.
      1) Waterproof walls, floors, and other building elements that at any time are subject to hydrostatic pressure, are below the water table, or are liable to be immersed in water.
      2) Cementitious waterproofing is not allowed.
      3) Bentonite clay shall be used for waterproofing at all walls and floors below the water table or otherwise subject to high hydrostatic pressures.
   d. Exterior sealants.
      1) Exterior sealants shall be two-part composition, able to accept 50% movement.

2) A minimum 10-year life expectancy shall be provided under severe weather conditions (20-years under mild conditions).
3) Sealants shall have low VOCs within LEED limits.
4) Sealants shall be compatible with the surfaces on which they are being applied and are non-staining.
5) Seal all exterior joints airtight and waterproof.
6) Sealants shall not be relied upon for waterproofing.

e. Insulation.
1) Combustibility of insulation, including wrappings, inside the building skin shall be limited to flame spread of 25 and smoke developed of less than 50.
2) Do not use spray-on or foamed-in-place polyurethane insulation.
3) Insulation shall meet the minimum recycle material content per LEED certification.
4) Roof insulation shall have a minimum thermal resistance of R-30. Refer to the 2010 edition of ASHREA 90.1 “Energy Standard for Buildings Except Low-Rise Residential Buildings”.

7. Exterior stairs.
a. Exterior stairs shall be a minimum of 4’-0” wide.
b. Provide slip resistant stair treads.
c. Cover exterior egress stairs as required by IBC.

D. Building Interior.
1. Materials selection.
a. The selection of materials shall be compatible with the architectural concept and the performance requirements outlined in Section 01 11 00, Summary of Work.
b. Use materials with higher percentages of recycled content wherever practical.
2. General requirements.
a. The building’s interior organization shall provide functional spaces as required to optimize research activity and as required for optimal operation of research equipment refer to Section 01 11 00, Summary of Work for additional.
b. Corridors shall be a minimum of 5’-0” wide.
c. All finish materials for walls, ceilings, and floors, a well as open plan partition assemblies, shall have a Class A rating, with a flame spread less than or equal to 25, a fuel contribution of less than or equal to 25, and a smoke development of less than or equal to 450.
3. Partitions.
a. Typical walls and partitions shall stop a minimum of 6” (where possible) above the finished ceilings unless otherwise required to provide optimal performance of the operational requirements of the research equipment operational sensitivities of the microscope identified in section 01 10 00 Summary of Work
b. Where required for fire rating, sound, security, or environmental control, walls shall be extended to the underside of the roof.
c. Wood framed partitions shall not be used, and wood blocking shall be minimized.
d. In addition to code locations, management suites, lunchrooms, break rooms, conference rooms, restrooms, and laboratories shall have walls extending from the floor to the structural ceiling/slab above and shall be fully insulated for the purposes of sound attenuation.
e. Where interior concrete block walls are used, the joints shall be struck flush and the walls sealed and painted.

f. Structural Fiberboard and laminated paperboard shall contain a minimum recycled content as per the LEED certification.
g. Whether or not required by code, fire rated partitions shall be clearly marked above the ceiling in red letters not less than 4” tall minimum, indicating the rating of the wall (one hour, two-hour, smoke partition, etc.), at 20’ maximum spacing and maximum of 15’ from end of wall. Sticky-back labels shall be provided by ORNL.

4. Floors.
   a. Floor coverings are not required for electrical closets (rooms), or mechanical rooms. In these areas painted or sealed concrete finishes shall be provided.
   b. Floor coverings.
      1) Carpet.
         a) See Interior finish standards in Section 01 84 19.
         b) Provide carpet squares in all areas to receive carpet.
         c) Critical radiant flux of 0.45 W/sq. cm. (Class I), or 0.22 W/sq. cm. (Class II) in accordance with NFPA 101 floor finish criteria.
         d) Use adhesives that comply with LEED VOC limits.
      2) Epoxy floor coatings.
         a) Epoxy floor coatings shall be selected to meet performance requirements under the specified exposures.
         b) Installation shall be performed or supervised by a certified installer.
      3) Vinyl composition flooring.
         a) See Interior finish standard in Section 01 84 19.
         b) Vinyl composite flooring shall be selected to meet performance requirements under the specified exposures.
      4) Floor tiles.
         a) See Interior finish standard in Section 01 83 00.1.
         b) Floor tiles shall contain minimum recycle content as per the EPA Comprehensive Procurement Guidelines.
5. Base
   a. See Interior finish standard in Section 01 84 19.
   b. Unless otherwise approved by the Company, provide minimum 4” high, 1/8” thick rubber cove baseboards in all areas with carpet, paint or sealer, and vinyl composition flooring.
6. Ceilings.
   a. See Interior finish standard in Section 01 84 19.
   b. Finish ceilings are not required for janitor closets, electrical closets (rooms), or mechanical rooms.
   c. Area above suspended ceiling shall not be used as an air plenum unless approved by the Company.
7. Doors.
   a. Interior doors shall be a minimum of 3’-0” by 7’-0”.
   b. Provide 1 ¾” thick solid core wood doors unless otherwise required to meet the performance requirements of the microscope, fire codes or as approved by the Company.
   c. Where interior hollow metal doors are used, they shall be minimum 18-gage, flush-face, welded construction.
   d. All locksets, including dead bolts, shall be specified to receive Best 7-pin A Series lock cores with master keying by the Company. Refer to Section 01 86 33, Security, for security requirements.

e. Frames shall be minimum 2” hollow metal frames, minimum 16 gage, welded construction and ground smooth. Knock-down frames may be used with prior acceptance from the Company.

f. Overhead roll-up door sill condition shall be designed to prevent the intrusion of water by offsetting the exterior and interior slab elevation a minimum of ½”. The exposed edge/corner of the interior slab shall have an embedded angle.

8. Paint.
   a. See Interior finish standard in Section 01 84 19.
   b. All items without factory-applied finishes and exposed to view shall be painted, unless otherwise specified.
   c. Consolidated and reprocessed latex paint shall be used when practical and shall contain a minimum recycled content as per LEED certification.
   d. Paints selected shall meet the VOC limits of LEED certification.
9. Interior sealants.
   a. Interior sealants shall be one-part, permanently flexible, but with a tough exterior film.
   b. Sealants shall have low VOC content complying with LEED limits.
10. Furnishings.
   a. Window coverings.
      1) Window coverings shall block out undesirable sun in areas normally occupied.
      2) ORNL standard window covering is MECHO roller shades and shall be used in all cases. Provide electrically operated shades for conference rooms and areas where manual operation is not practical.
   b. Manufactured casework.
      1) Use modular units and dimensionally interchangeable elements.
      2) To the extent practical, use stock sizes, materials, and finishes.
   c. Millwork.
      1) Millwork shall conform to the Architectural Woodwork Institute Quality Standards, Guide Specifications and Quality Certification Program, latest edition.
      2) Millwork and architectural woodwork items are permanently attached to the building and/or built-in place.
   d. Restroom Dividers/Partitions
      1) Restroom Dividers/Partitions shall contain a minimum recycled material content as per the EPA’s Comprehensive Procurement Guidelines whether plastic or steel is used.
   e. Toilet Accessories.
      1) Provide seat cover dispensers for all water closet stalls.
      2) Provide soap dispensers for each pair of sinks as a minimum, but preferable for each individual sink. Soap dispensers shall be: C6/1250 ADX-12 Black/Chrome Dispenser. No substitutes allowed.
      3) Preferably provide paper towel dispensers for each pair of sinks as a minimum, or logistically located if a central dispenser is used. Paper towel dispensers shall be Georgia Pacific enMotion Automatic Touchless type in smoke gray or stainless steel. – no substitutes allowed.
      4) Toilet paper dispensers shall be provided in each stall and shall be Georgia Pacific Vista Jumbo Jr., Translucent Smoke, manufacturer’s item number 59209 - no substitutes allowed.

5) Provide faucet for water hose under lavatory in each toilet area.

f. Janitor Closet
1) A Janitor Closet shall be provided on each floor of the building, easily accessible for cleaning, and near the elevator.
2) Closet shall include mop sink, faucet with bucket hook, storage for supplies, and hanging apparatus for mops and brooms, as well as storage for vacuum and mop bucket trolley.

11. Fire extinguisher cabinets
a. Fire extinguisher cabinets shall be stainless steel, fully recessed unless otherwise approved by the Company.
b. Cabinets must accommodate Ansul Sentry SY 10-14, 10-pound, ABC extinguishers. Extinguishers will be provided by the Company.

12. Signage.
a. Interior signage complying with ORNL standard signage specifications, Section 01 84 23, shall be provided for identification of all interior spaces.
b. Exterior (building identification) and interior signage shall be approved by the Company.
c. During the contract document drawing phase, provide numbering for all spaces in a manner which facilitates the final way-finding plan and avoids the need to re-number spaces for signage. The room numbering scheme shall be approved by the company prior to finalizing interior signage package.
d. Area of Refuge signage shall include Sign “FOR RESCUE ASSISTANCE LIFT TELEPHONE FOR DIRECT CONNECTION TO LABORATORY SHIFT SUPERVISOR (LSS)”. Message shall also appear in Braille.

E. Landscaping / Seeding

1. Design
a. A complete landscape design and specification shall be provided by the AE.
b. All plant materials shown on the landscaping plan shall be selected from the ORNL approved plant list available on line at: http://web.ornl.gov/adm/fo/nr/lm/Documents.htm
c. Irrigation design shall be included in the landscape package.
d. The design shall integrate drainage, pathways, and hardscape as integral parts of the landscape. Plantings shall be used to provide filtration of storm water path and water retention features as an integral part of storm water control systems.

2. Preparation
a. In preparation for landscaping, subgrade shall be contoured to 6” below finish grade. Subgrade shall be free of ALL rock, stone, roots, and other mater that will interfere with planting growth.
b. Scarify the top 4” of subgrade to allow mixing with base layer of topsoil.
c. Store topsoil for reuse as approved by the Company.

3. Irrigation
a. Provide an exterior connection point, with backflow preventer, for future installation of irrigation system to be provided as GFE.
b. An interior valve shall be provided to control the connection point.
c. The irrigation system will be installed as GFE.

4. Landscaping
a. Landscaping shall be provided by the Company including topsoil, planting mix, plant materials, seeding and straw, and river stone accents.

b. The Contractor shall cooperate fully with the landscaper for access to the site for installation of landscaping.
c. Cleanup of all areas disturbed or soiled by the landscaper will be the responsibility of the landscaper.

END OF SECTION 01 83 00

SECTION 01 84 19 – INTERIOR FINISH STANDARDS

PART 1 - PROJECT REQUIREMENTS

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.

1.2 INTERIOR FINISH STANDARDS

A. See Table 01 84 19-A

Table 01 84 19-A	
Laboratory / Instrument Room / Lab Support	
Vinyl Composition Tile (typical)	Armstrong Flooring Color: #51908, Pweter
Vinyl Composition Tile (accent)	Armstrong Flooring Color: #51927, Field Gray
Sheet Vinyl (wet labs)	Mannington, Biospec MD, Color 15364, New Glacier
Base	Johnsonite: 4” rubber cove #63, Burnt Umber
Wall paint (typical)	Sherwin Williams: Color: SW 7008, Alabaster
Clean Room Walls	Fiber Reinforced Plastic Panels (FRP) with Trim-Free Seam
Ceiling Tile	Optima Open Plan Square Edge Model 3150
Ceiling Grid	White, 15/16" wide
Gyp Board Ceilings	Benjamin Moore Decorator White
Lab casework	Color, Bisque
Lab countertops (typical)	Composite Polymer: Color Black
Entry and Entry Vestibule	
Walk off matt Style 12901 Color 7187, Black	Interface "Entry Level"
Base	As approved by the ORNL
Wall paint (typical)	SW 7008, Alabaster
Gyp Board Ceilings	Benjamin Moore White
Lab Service Corridors	
Vinyl Composition Tile (typical)	Armstrong Flooring Color: #51908, Pweter
Vinyl Composition Tile (accents)	Armstrong Excelon Flooring Colors: #51927, Field Gray
Base	Johnsonite - Color: #63, Burnt Umber
Wall paint (typical)	Sherwin Williams - Color: SW 7008, Alabaster
Ceiling Tile	Optima Open Plan Square Edge Model 3150
Ceiling Grid	White, 15/16" wide
Gyp Board Ceilings	Benjamin Moore Decorator White

PART 2 - NOT USED

PART 3 - NOT USED

END OF SECTION 01 84 19

SECTION 01 84 23 – SIGNAGE

PART 1 - PROJECT REQUIREMENTS

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.

1.2 SUMMARY

A. All interior signs and graphics exposed to view of the public and staff as noted below for the Oak Ridge National Laboratory (ORNL) and described in the signage drawings and related documents.

1. The following sign types are included in this work:

   a. Sign Type 1 – Americans with Disabilities (ADA) room identification signs.
   b. Sign Type 2 – evacuation plan holders.
   c. Sign Type 5 – reception desk logo.
   d. Sign Type 8 – division name signs.
   e. Sign Type 9 – room identification – staff.
   f. Sign Type 10 – Utility Room identification – staff.
   g. Sign Type 11.1 – hazard insert.
   h. Sign Type 12 – fire extinguisher sign.
   i. Sign Type 12.1 – fire pull flag sign.
   j. Sign Type 12.2 – emergency eyewash sign.
   k. Sign Type 12.3 – emergency shower and eye wash sign.

2. Each type of sign is indicated on the drawings and requires various materials, finishes, fabrication, and installation techniques.

3. Provide a signage drawing depicting the locations, types, and graphics for each sign required.

B. Requirements for shop drawings, layouts, mock-ups, and samples for the Company's approval.

C. Structural design and calculations when appropriate to substantiate design.

D. Installation of all signs, including all fasteners and fastenings.

E. Coordination with the Company during all phases of development, fabrication and installation.

F. Development of sign schedules by the sign contractor listing the specific, final message for each sign based on input from the Company and use of the design drawings for sign layouts. This work also includes correct Grade II Braille interpretations for messages requiring corresponding Braille.

G. Provide sign insert layouts, electronic templates for inserts and software required for generation of future sign inserts by the Company. Intent is that the Company will be able to produce future inserts without sign contractor's involvement.

1.3 SUBMITTALS

A. Specifications and instructions: submit to the Company for information only, two copies of manufacturer's specifications and installation instructions, in addition to shop drawings, for each applicable type of sign.

B. Shop drawings shall be prepared by the sign contractor for all items called for, in detail for all signs noted including full size sections of typical members. Submit prints thereof as called for elsewhere in this document. These shop drawings will indicate applicable method and type of anchorage, field dimensions, and accessory items including material types, thickness, gages and finishes. Provide template drawings for stud and anchorage fastening locations. At the conclusion of the work contractor shall provide the Company, as part of a maintenance manual, copies of as-built shop drawings that fully record any changes to the signs.

Note: Copies of the attached design documents do not constitute shop drawings.

C. Submittal of samples: submit to the Company three copies of each different finish, color and substrate material. All samples shall be 6"x6" minimum in size, properly labeled for use and intent. One approved sample shall remain at the manufacturer's plant during fabrication to serve as quality standard for color and finish.

D. Full scale layouts:

NOTE: the sign drawings and layouts have been generated via computer and the fonts used are readily available for reproduction.

1. Letter and word spacing is to match that shown on the drawings. Submit full scale sample layouts in the form of messages, templates, or pen plots for approval of letter and word spacing for sample messages. Provide such layouts for each message at each size it is used. Multiple messages of one size, such as ‘Women’ need only be submitted once in each different size. It is a requirement of the contract that letter and word spacing be approved by the Company.

   NOTE: Do not substitute any fonts or graphic elements for those shown on the drawings.

E. Full scale graphic elements: submit full scale layouts or agreed-upon scaled layouts in the form of templates, or pen plots of each symbol, project arrow, or other graphic element on the project. Where elements are repeated on several sign types, submit only one copy at each size for approval.

F. Submit signage guarantee: the sign contractor shall guarantee all workmanship and material for the product he has furnished and erected for a period of one year after the final acceptance of the product, and if during the guarantee period any defects or faulty materials are found he shall immediately upon notification by the Company proceed at his own expense to replace and repair same, together with any damage to all finishes, fixtures, equipment and furnishings that may be damaged as a result of this defective equipment or workmanship.

G. Maintenance data and operating instructions: manufacturer's instructions and recommendations for maintenance and cleaning of products shall be provided as a project manual to accompany as-built shop drawings referenced in Item B above.

PART 2 - CODES AND STANDARDS

2.1 QUALITY ASSURANCE

A. For the purposes of continuity in design and finished product, the contractor shall use a single signage subcontractor for execution and installation of all the signs in the contract unless otherwise specifically stated by the Company.

B. Fabricator qualifications: it is required that the fabricator and any subcontractors for the work have in-house, the broad knowledge, diverse shop and field experience, flexibility, coordinating ability, skilled craftsmen, and physical plant necessary to produce quality products as judged by the Company.

C. Design criteria.

1. Structural design: details on drawings indicate a design approach for sign fabrication but do not necessarily include all fabricating details required for the complete structural integrity of the signs, including consideration for static, dynamic and erection loads during handling, erection and service at the installed locations, nor do they necessarily consider the preferred shop practices of the individual general sign fabricators. It shall be the responsibility of the fabricator to perform the complete structural design of the applicable signs and to incorporate all the reasonable safety factors necessary to protect the Company against public liability. Minimum design requirements shall be as specified in the 2006 International Building Code (IBC).

   a. Include anchor hardware as a part of the sign and graphics work.
   b. Attachments to metal structures and existing ceilings must be approval of the Company. Whenever design calculations are required, they shall be designed by an engineer currently registered in the state of Tennessee and shall be submitted to the Company for approval.

D. Requirements of regulatory agencies: comply with all life safety and state of Tennessee building codes and all other code agencies having jurisdiction over the project. Notify the Company of any conflicts between the specifications and such agencies.

2.2 PRODUCT HANDLING

A. Procedure: pack, wrap, crate, bundle, box, bag, or otherwise package, handle, transport and store all fabricated work as necessary to provide protection from damage by every cause. Properly label all cartons, boxes or other containers with list of contents.

2.3 WARRANTY

A. Warrant all work against failure because of faulty materials, workmanship, and design for a period of one year from date of substantial completion.

B. Fading, cracking, warping, peeling, delamination, rusting, corroding, and structural failure, including distortion by whatever cause, shall be construed to mean failure because of faulty materials and workmanship.

C. Failures during the warranty period shall be repaired or replaced to the satisfaction of the Company and at no cost to the Company.

2.4 MAINTENANCE MATERIALS

A. Touch-Up paint: provide the Company with one quart can of touch-up paint of each color, thinner and cleanup solvent, and instructions for use. Label all such items. Reference use of maintenance materials in the aforementioned maintenance manual to be provided the Company.

2.5 INSPECTION

A. The Company reserves the right to inspect work in the fabrication shop before it is shipped to the job site for installation.

B. Fabricator shall inspect installation locations for conditions which will adversely affect execution, permanence and quality of work and shall notify the Company of any discrepancies and shall not proceed with installation until the conditions have been addressed.

PART 3 - PRODUCTS

3.1 FABRICATION AND INSTALLATION – GENERAL

A. The following information describes in general terms the products to be provided in this contract and the expectations of the Company. Any deviation from this expectation is to be approved by the Company prior to execution of the work.

B. Sign types.

1. The following descriptions are a synopsis of the design intent and are further illustrated on the design drawings.

a. Sign Type 1 – ADA room identification signs.
   1) The ADA compliant plaques fabricated of painted acrylic with vinyl graphics and photopolymer panel with room name or number and corresponding Grade II Braille.
   2) Mount to various surfaces using double faced foam core tape and silicone adhesive.

b. Sign Type 2 – evacuation plan holders.
   1) Insert holders fabricated of acrylic layered up with spacers to accept a page size insert slipped into a slot accessible from both ends of the sign. Header and footer painted. Vinyl graphics applied to header per drawing layout.
   2) Insert computer generated color output onto card stock or onto paper stock laminated both sides. Sign contractor to provide evacuation plan inserts for each sign location.
   3) Mount to wall surfaces using double faced foam core tape and silicone adhesive.

c. Sign Type 8 – division name signs.
   1) Changeable sign fabricated from layered acrylic to provide a pocket for card stock insert accessible from both sides of sign. Paint header and footer to conceal spacers. Carry color of header and footer around to sides of signs. Graphics white vinyl applied to header along with ADA compliant room number panel made of photopolymer.
   2) Provide computer generated card stock inserts with messages to be provided by the Company.
   3) Mount to various wall surfaces using double faced tape and silicone adhesive. Should weight of sign warrant, add minimum of two mounting studs threaded into back of sign for intent of carrying shear load of sign.

d. Sign Type 9 – room identification – staff.
   1) Changeable sign fabricated from layered acrylic to provide a pocket for card stock insert accessible from both sides of sign. Paint header and footer to conceal spacers. Carry color of header and footer around to sides of signs. Graphics white vinyl applied

to header along with ADA compliant room number panel made of photopolymer.

2) Provide computer generated card stock inserts with messages to be provided by the Company.

3) Mount to various wall surfaces using double faced tape and silicone adhesive. Should weight of sign warrant, add minimum of two mounting studs threaded into back of sign for intent of carrying shear load of sign.

e. Sign Type 10 – Utility Room identification – staff.

1) Changeable sign fabricated from layered acrylic to provide a pocket for card stock insert accessible from both sides of sign. Paint header and footer to conceal spacers. Carry color of header and footer around to sides of signs. Graphics white vinyl applied to header along with ADA compliant room number panel made of photopolymer.

2) Provide computer generated card stock inserts with messages to be provided by the Company.

3) Mount to various wall surfaces using double faced tape and silicone adhesive. Should weight of sign warrant, add minimum of two mounting studs threaded into back of sign for intent of carrying shear load of sign.

f. Sign Type 11.1 – hazard insert.

1) Laminated card stock bearing message to be determined by the Company. Provide inserts in quantity to be determined by the Company. Laminate final inserts and trim laminate so that laminate does not protrude out of insert slot.

g. Sign Type 12 – fire extinguisher signs.

1) Sign panels cut from 1/8" thick acrylic cut to shape and painted red all surfaces. Apply white vinyl graphics to sign face. Mount sign panels to T shaped aluminum extrusion using double faced tape and silicone adhesive. Provide spacer 1" inside outer edge of sign assembly to maintain uniform thickness of space between sign panels. Paint spacer black so that it is not seen.

2) Mount sign brackets to wall surfaces using flush, countersunk fasteners.

h. Sign Type 12.1 – fire pull flag signs.

1) Sign panels cut from 1/8" thick acrylic cut to shape and painted red all surfaces. Apply white vinyl graphics to sign face. Mount sign panels to T shaped aluminum extrusion using double faced tape and silicone adhesive. Provide spacer 1" inside outer edge of sign assembly to maintain uniform thickness of space between sign panels. Paint spacer black so that it is not seen.

2) Mount sign brackets to wall surfaces using flush, countersunk fasteners.

i. Sign Type 12.2 – emergency eyewash sign.

1) Sign panels cut from 1/8" thick acrylic cut to shape and painted dark green all surfaces. Apply white vinyl graphics to sign face. Mount sign panels to T shaped aluminum extrusion using double faced tape and silicone adhesive. Provide spacer 1" inside outer

edge of sign assembly to maintain uniform thickness of space between sign panels. Paint spacer black so that it is not seen.

2) Mount sign brackets to wall surfaces using flush, countersunk fasteners.

j. Sign Type 12.3 – emergency shower and eyewash sign.

1) Sign panels cut from 1/8" thick acrylic cut to shape and painted dark green all surfaces. Apply white vinyl graphics to sign face. Mount sign panels to T shaped aluminum extrusion using double faced tape and silicone adhesive. Provide spacer 1" inside outer edge of sign assembly to maintain uniform thickness of space between sign panels. Paint spacer black so that it is not seen.

2) Mount sign brackets to wall surfaces using flush, countersunk fasteners.

k. Sign Type 14 – vinyl graphics at entrances.

1) Graphics shall be premium cast 2-mil vinyl as manufactured by 3M, or approved equal, and cut using computer controlled device for accurate reproduction of typography and graphic elements. Apply directly to clean sign surfaces.

NOTE: This spec shall be used for all vinyl messages used on every sign type where vinyl is called for.

3.2 MATERIALS - PLASTICS

A. Acrylic: made with methyl methacrylate polymers, as manufactured by Rohm and Haas, or equivalent as approved by the Company.

1. Provide solid sheet, laminated sheet, or cast acrylic in size, thickness, clarity, opacity, texture, and color noted in drawings.

3.3 MATERIALS - ADHESIVE FILM (VINYL GRAPHICS)

A. Vinyl graphics: where ever noted in these specifications, pressure sensitive adhesive type, cast 2-mil premium vinyl, pre-spaced, gloss finish, manufactured by 3M Corporation, Gerber Scientific Products, Anacast, Inc., or approved equal. Apply free of air pockets, bubbles, or other surface blemishes or deformities.

B. Where graphics are photo-silkscreened onto vinyl sheet, use screen ink appropriate for exterior conditions and compatible with vinyl.

3.4 MATERIALS - MISCELLANEOUS

A. Adhesives:

1. Silicone: clear silicone adhesive #1201 as manufactured by General Electric (GE) or #732 silicone adhesive as manufactured by Dow Corning as approved by the Company.
2. Epoxy: type approved by the Company.
3. Versiloc adhesive as manufactured by Lord Chemical Company.
4. Adhesive tapes – double-faced tape: 1/16" thick, or thinner, foam core tape with adhesive both sides as manufactured by 3M or equal. Color of tape to be black or white to match the color of the surface the sign is installed upon, i.e.: signs or letters installed on light colored walls use white tape; signs or letters installed on dark walls use black tape.
5. Cement for acrylic plastic. No. 4 cement by Industrial Polychemical Co., or approved equal.

3.5 MATERIALS - PAINT

A. Exposed surfaces: paint to be two-component acrylic polyurethane formulation as manufactured by Mathews Paint Company, Wyandotte Paint Company, or approved equal. Apply primers and finish coats according to manufacturer’s instructions. Finish shall be eggshell.

B. Samples: provide required samples of paint for approval on properly cleaned and primed material paint is to be ultimately applied to.

C. Colors: various finishes and colors have been used in the building and sign colors have been chosen to compliment and work with the building design elements. A list of colors will be provided to the successful contractor. Colors are noted on drawings in a generic manner, i.e., 'dark green'; 'yellow', etc. The intent is to match the specified colors.

3.6 WORKMANSHIP – GENERAL

A. Trades-Work: it is intended that the workmanship be of the highest quality obtainable by the respective trades and crafts experienced in the fabrication of signs, and that all work be done by journeymen, or by tradesmen under the direct supervision of journeymen.

1. "Journeymen" shall be interpreted to mean those craftsmen who have the qualifications and experience to meet the requirements described in the Job Classification and Descriptions for the Electric Sign Industry, as developed by the National Electric Sign Association (NESA)/TRI-Trades Committee.

B. Artisans: it is intended that work of an artistic or specialized nature such as laser-cutting and engraving, artistic painting, when included as part of the contract, be executed by artisans with experience, credentials, and reputation to satisfy the demands of the Company.

3.7 FABRICATION – GENERAL

A. Intent of specifications: it is intended that all finished work be of the highest quality to pass eye-level examination and scrutiny by the Company.

1. Construct all work to eliminate burrs, cutting edges, and sharp corners.
2. Finish welds on exposed surfaces to be imperceptible in the finished work.
3. Except as indicated or directed otherwise, finish all surfaces smooth.
4. Surfaces which are intended to be flat shall be without bulges, oil-canning, or other physical deformities.
5. Surfaces which are intended to be curved shall be smoothly free-flowing to required shapes.
6. Except where approved otherwise by the Company, conceal all fasteners.
7. Make access panels tight-fitting and flush with adjacent surfaces.
8. Conceal all identification labels inside signs. Do not apply labels of any type which cannot be concealed. Provide sample of all labels to the Company for review of size and location.
9. All material shall be new stock, free from defects impairing strength, durability, and appearance.
10. No fabrication of installation materials or procedure shall be used that will in any way change the visual quality or in any manner have an adverse effect on existing materials and surfaces.
11. All adhesives shall be used in accordance with recommendations made by the manufacturer of the materials to be laminated or adhered.
12. No adhesives that will fade, discolor, or delaminate as a result of proximity to ultraviolet light source or heat therefrom shall be used, and shall not change the color of or deteriorate the materials to which they are to be applied. The adhesives shall be of non-staining, non-yellowing quality, and all visible joints shall be free from air bubbles and other defects.
13. Sign faces must be clean and free of glue or other foreign material. Edges to be smooth and straight.
14. Painted surfaces to be resistant to crazing, peeling, scratching and fading. All coatings shall conform to manufacturer’s requirements.
15. Full size original art for each sign shall be prepared by the contractor. The messages are to be photo-typeset or computer generated; no hand-cutting of screens or templates is permitted. All symbols, logos, etc. are to photographically reproduced, or computer generated.
16. If messages do not fit in a specific format shown on the drawings, submit alternate layout of the message in question to the Company for approval.
17. All lettering shall be executed in such manner that all edges and corners of finished letter forms are true, sharp and clean. Letterforms with rounded positive or negative corners, edge build-up, bleeding, saw-toothing, pinholes, etc. will not be accepted.
18. All vinyl letters or silk-screening shall be on the top surface of the recommended material unless otherwise specified on the drawings.
19. All letterforms shall be aligned as to maintain a base line parallel to the sign format unless otherwise noted.
20. All die-cutting or computer generated knife cutting shall be executed in such a manner that all edges and corners of finished letterforms are true and clean. Letterforms with rounded positive or negative corners, niched, cut or ragged edges, etc. will not be accepted.

21. All inks and paints required for engraving or silkscreen and imprinted surfaces shall be of a type made for the surface material on which it is applied and recommended by the manufacture of the ink or paint. Exact identification of all inks and paints shall be noted on the shop drawings, together with date describing the method of application, if other than 'air drying'.

22. No paints or inks that will fade, discolor, or delaminate as a result of proximity to ultraviolet light source or heat therefrom shall be used.
23. All inks and paints shall be evenly applied and without pinholes, scratches, orange peeling, application marks, and other defects. Workmanship in connection with finishes and formation of letters shall conform to the highest standards of the trade.
24. Cleaning of any kind, prime coats or other surface pre-treatment, where recommended by the manufacturer for inks and paints, shall be included in the work as part of the finished surface work at no extra cost to the Company.
25. Carefully follow manufacturer's recommended fabricating procedures regarding expansion, contraction, fastening, and restraining of acrylic plastic or glass.
26. Exercise care to assure that polished and plated surfaces are unblemished in the finished work.
27. Isolate dissimilar materials. Exercise particular care to isolate non-ferrous metals from ferrous metals.

3.8 INSTALLATION – GENERAL

A. Verify the exact location with the Company at the job-site for all signs which are not exactly dimensioned on the drawings.

B. Securely anchor work in proper location using anchors, anchorage's, fasteners, or other methods approved on shop or erection drawings. All anchors and fasteners shall be appropriate for the anchorage condition. All hardware in locations subject to moisture or other corrosive elements are to be stainless steel.

C. Final adjustments and cleaning:

1. Touch up all scratched, marred, abraded, or otherwise damages surfaces to match original finishes.
2. Clean-Up work area after installation has been completed.
3. The Company is the final arbiter on interpretation of the documents. Questions concerning format, actual message copy, and actual sign location should be forwarded to the Company in writing. Decision by the Company as to compliance with the documents will be final.

Drawing List

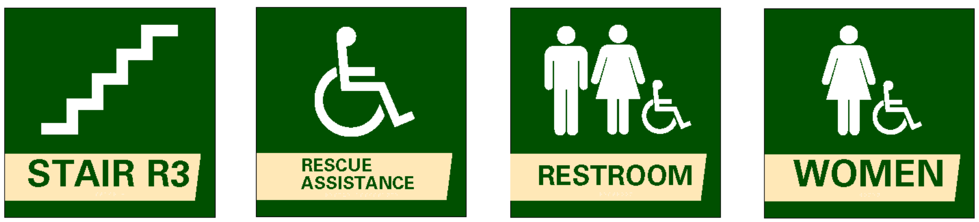
EC.A	Graphic Elements
EC.1	Sign Type 1 - ADA Room Identification Signs
EC.2	Sign Type 2 - Evacuation Plan Holders
	Sign Type 3 - Fire Stair Signs
EC.3	Sign Type 4 - Building Directory
EC.4	Sign Type 5 - Reception Desk Logo
EC.5	Sign Type 6 - Street Signs
EC.5.1	Sign Type 6.1 - Street Signs - Flag Mounted
EC.6	Sign Type 7 - Floor Directory
EC.7	Sign Type 7.1 - Directional Signs
EC.8	Sign Type 7.2 - Notice Holders - 11" x 17"
	Sign Type 7.3 - Notice Holders - 8 1/2" x 11"
EC.9	Sign Type 8 - Division Name Signs
EC.10	Sign Type 9 - Room Identification - Staff
	Sign Type 9.1 - Pod Identification - Staff
EC.11	Sign Type 10 - Utility Room Identification - Staff
	Sign Type 10.1
EC.12	Sign Type 11 - Lab Identification Signs
EC.12.1	Sign Type 11.1 - Hazard Insert
EC.13	Sign Type 12 - Emergency Marker Flag Signs
	Sign Type 12.1 - Fire Pull Flag Signs
EC.14	Sign Type 14 - Vinyl Graphics at Entrances

UT-BATTELLE

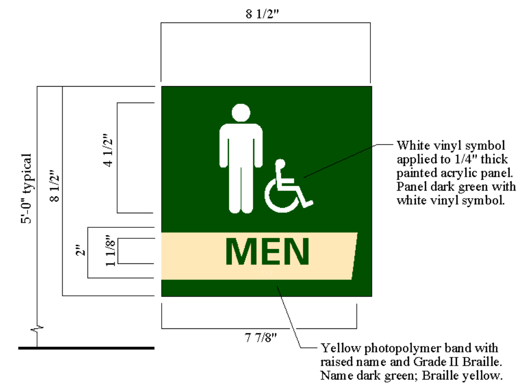
OAK RIDGE NATIONAL LABORATORY

SIGNAGE DESIGN

CONSTRUCTION DOCUMENTS



Stair sign for use on corridor side of stair doors. Stair numbers vary.

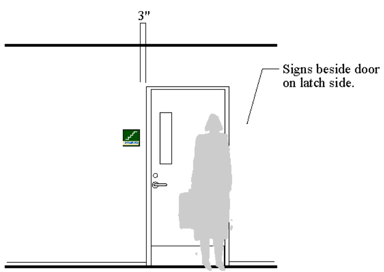


Typical Elevations *1/4"=1"*

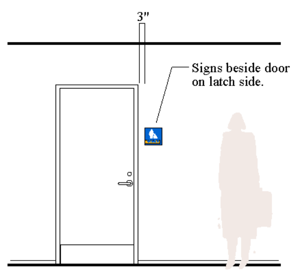
Confirm quantities of each sign layout with owner.

Sign Type 1 - ADA Room Identification Signs *1/4"=1"*

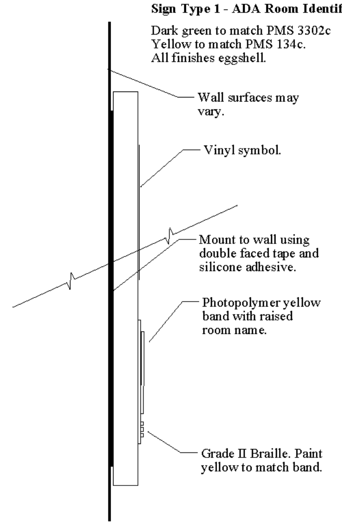
Dark green to match PMS 3302c
Yellow to match PMS 134c.
All finishes eggshell.



Typical Stair Sign Location *1/4"=1'-0"*



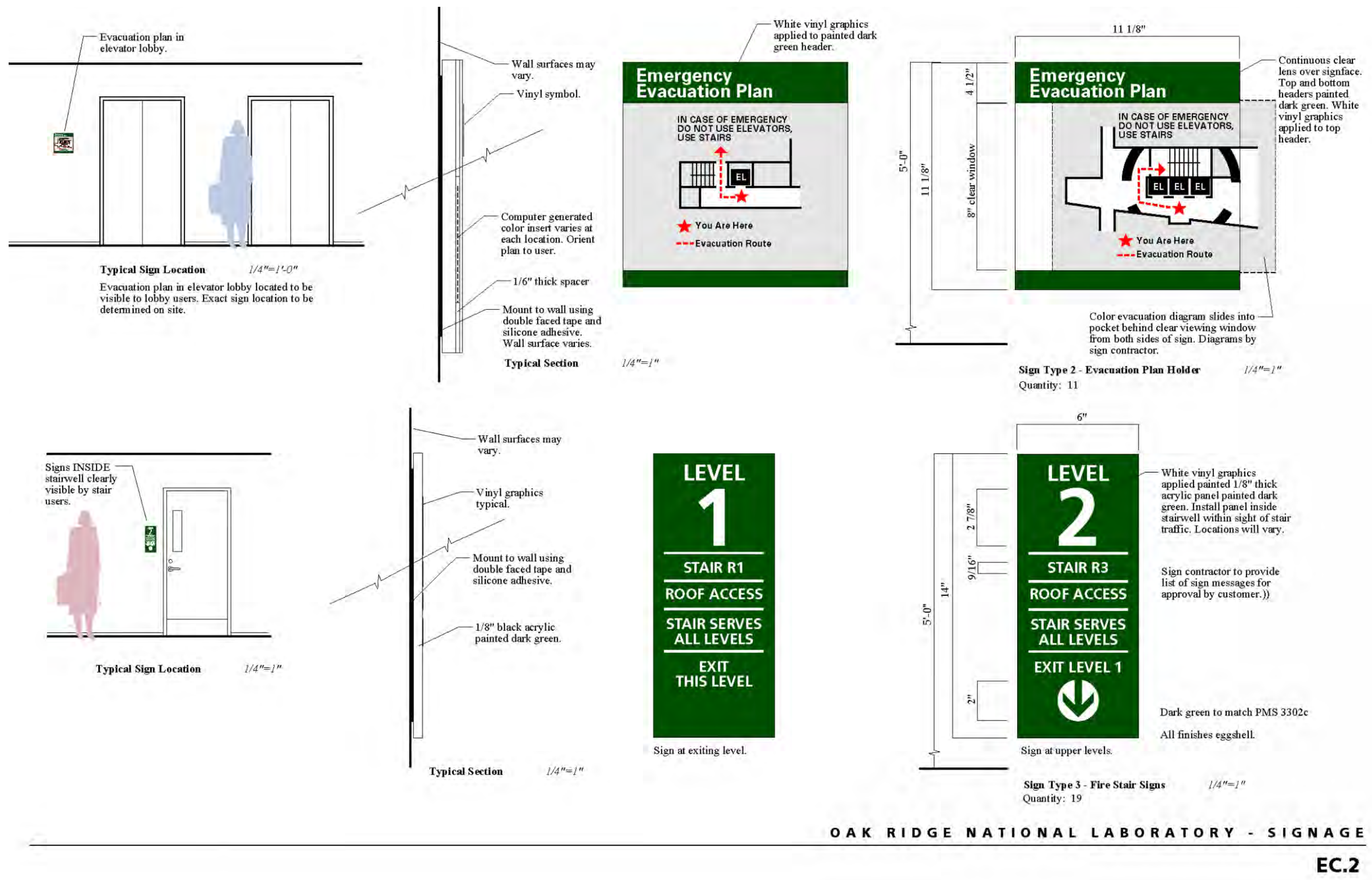
Typical Toilet Sign Location *1/4"=1'-0"*

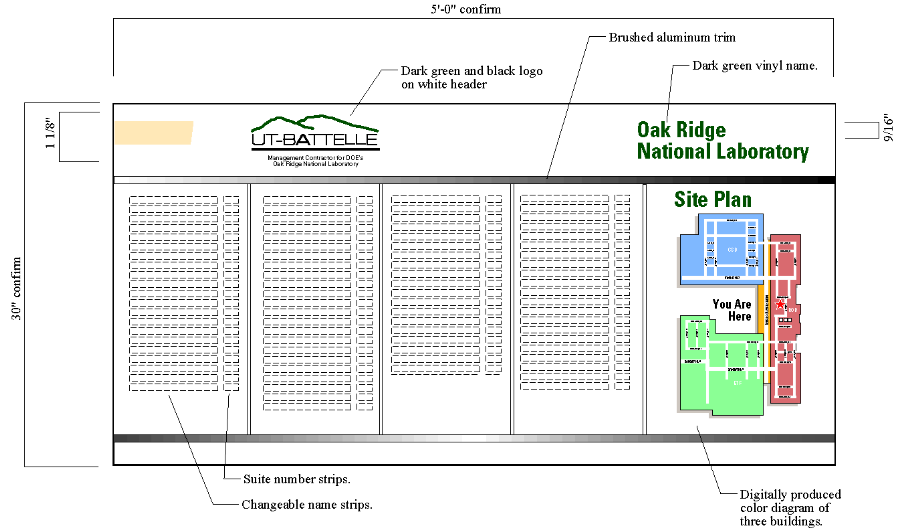


Typical Section *1/4"=1"*

OAK RIDGE NATIONAL LABORATORY - SIGNAGE

EC.1

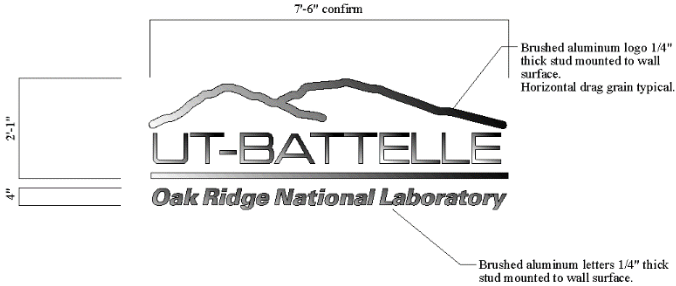

Evacuation plan in elevator lobby.
Typical Sign Location 1/4"=1'-0"
Evacuation plan in elevator lobby located to be visible to lobby users. Exact sign location to be determined on site.
Wall surfaces may vary.
Vinyl symbol.
Computer generated color insert varies at each location. Orient plan to user.
1/6" thick spacer
Mount to wall using double faced tape and silicone adhesive. Wall surface varies.
Typical Section 1/4"=1"
White vinyl graphics applied to painted dark green header.
Emergency Evacuation Plan
IN CASE OF EMERGENCY DO NOT USE ELEVATORS, USE STAIRS
EL
You Are Here
Evacuation Route
11 1/8"
5'-0"
11 1/8"
4 1/2"
8" clear window
Continuous clear lens over signface. Top and bottom headers painted dark green. White vinyl graphics applied to top header.
Emergency Evacuation Plan
IN CASE OF EMERGENCY DO NOT USE ELEVATORS, USE STAIRS
EL EL EL
You Are Here
Evacuation Route
Color evacuation diagram slides into pocket behind clear viewing window from both sides of sign. Diagrams by sign contractor.
Sign Type 2 - Evacuation Plan Holder 1/4"=1"
Quantity: 11
Signs INSIDE stairwell clearly visible by stair users.
Typical Sign Location 1/4"=1"
Wall surfaces may vary.
Vinyl graphics typical.
Mount to wall using double faced tape and silicone adhesive.
1/8" black acrylic painted dark green.
Typical Section 1/4"=1"
LEVEL 1
STAIR R1
ROOF ACCESS
STAIR SERVES ALL LEVELS
EXIT THIS LEVEL
Sign at exiting level.
6"
5'-0"
14"
2 7/8"
9/16"
2"
LEVEL 2
STAIR R3
ROOF ACCESS
STAIR SERVES ALL LEVELS
EXIT LEVEL 1
Sign at upper levels.
White vinyl graphics applied painted 1/8" thick acrylic panel painted dark green. Install panel inside stairwell within sight of stair traffic. Locations will vary.
Sign contractor to provide list of sign messages for approval by customer.))
Dark green to match PMS 3302c
All finishes eggshell.
Sign Type 3 - Fire Stair Signs 1/4"=1"
Quantity: 19
OAK RIDGE NATIONAL LABORATORY - SIGNAGE
EC.2



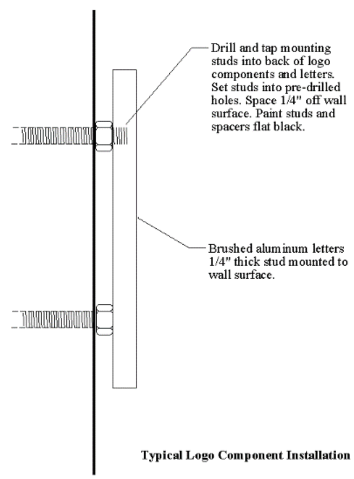
Sign Type 4 - Building Directory *1/4"=1"*

Mount directory in building lobby. Size to be determined.

Directory not lighted internally.



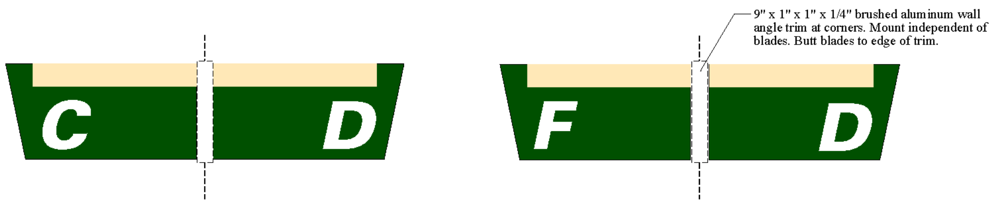
Sign Type 5 - Building Identification in Lobby *1/2"=1'-0"*



Typical Logo Component Installation *full size*

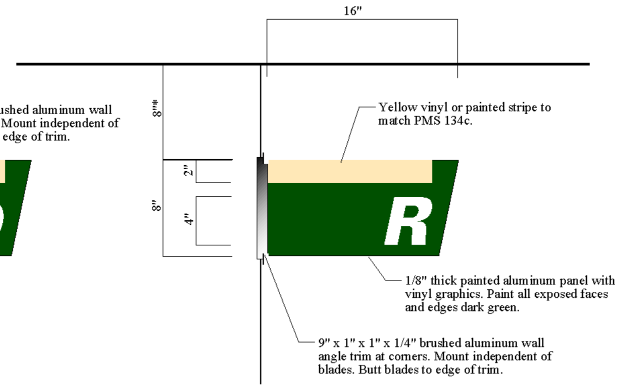
OAK RIDGE NATIONAL LABORATORY - SIGNAGE

EC.4



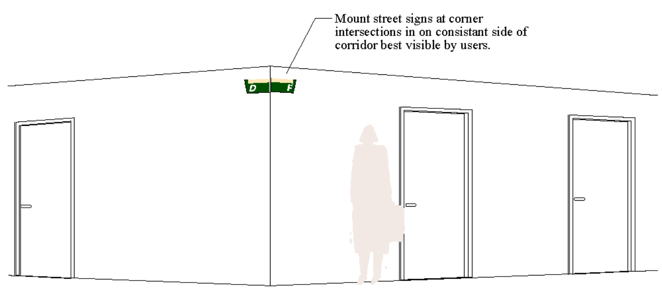
Typical Elevations (flattened) *1/8"=1"*
Shown 'flattened' at typical corner.

Dark green to match PMS 3302c
Yellow to match PMS 134c.
All finishes eggshell.

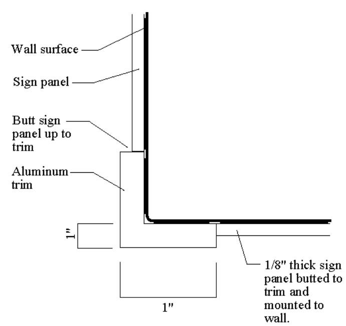


Sign Type 6 - Street Signs *1/8"=1"*

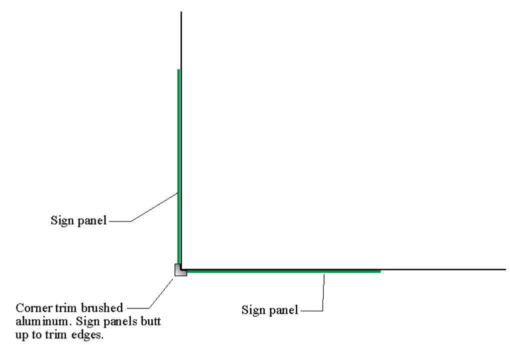
* Should conflicts arise with ceiling mounted components such as pipes, conduits, etc., distance down from ceiling may vary subject to owner's approval.



Typical Sign Location *1/4"=1'-0"*



Enlarged Corner Detail *full size*

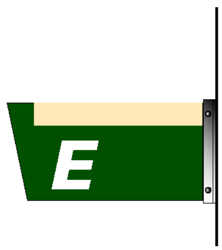


Plan View at Corner *1/8"=1"*

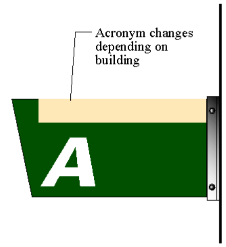
Signs mounted at each intersection of corridors.

OAK RIDGE NATIONAL LABORATORY - SIGNAGE

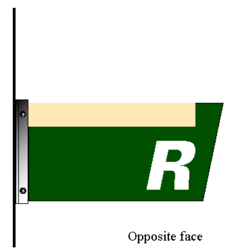
EC.5



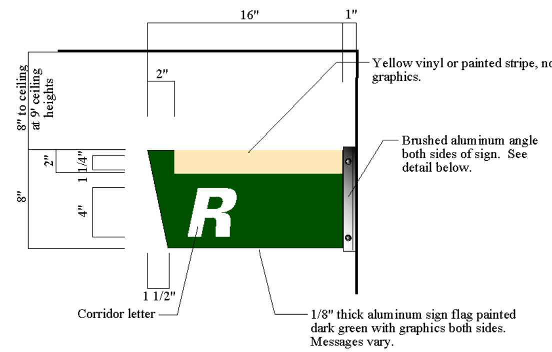
Sample layout from ETF.



Sample layout from CSB.

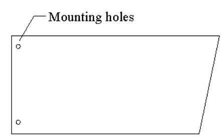


Opposite face

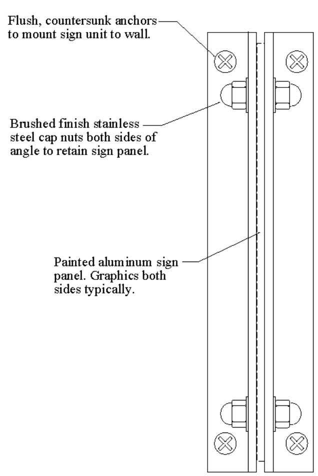


Sign Type 6.1 - Street Signs *1/8"=1"*

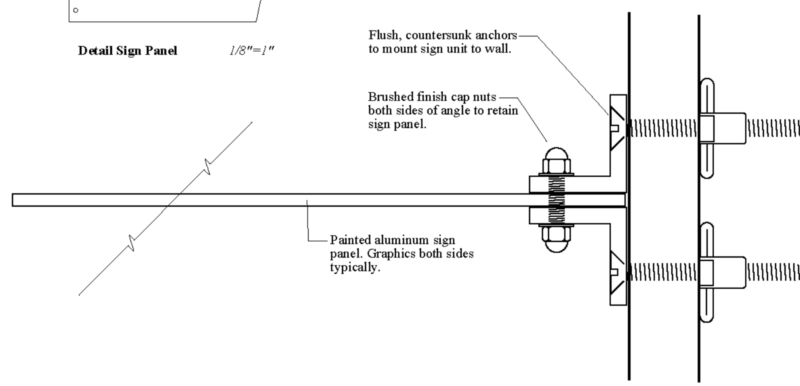
* Should conflicts arise with ceiling mounted components such as pipes, conduits, etc., distance down from ceiling may vary subject to owner's approval.



Detail Sign Panel *1/8"=1"*



End View *half size*

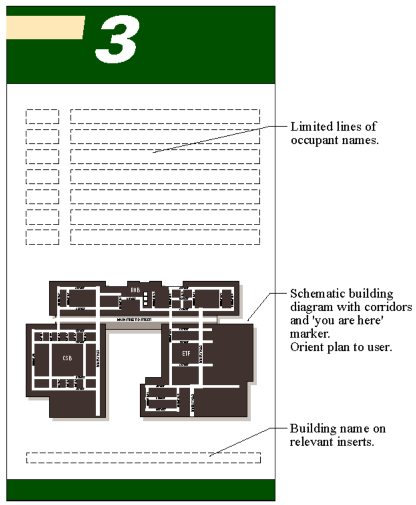


Plan View at Mounting Bracket *full size*

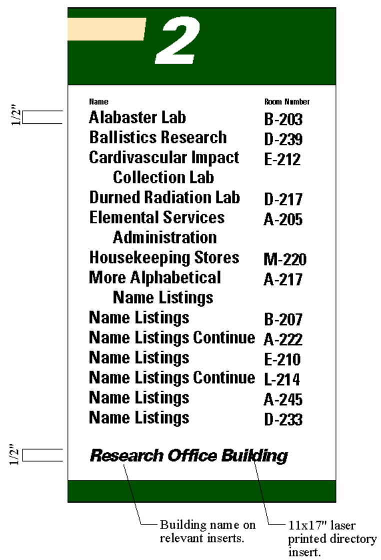
Confirm location of all flag signs along Main Street.

OAK RIDGE NATIONAL LABORATORY - SIGNAGE

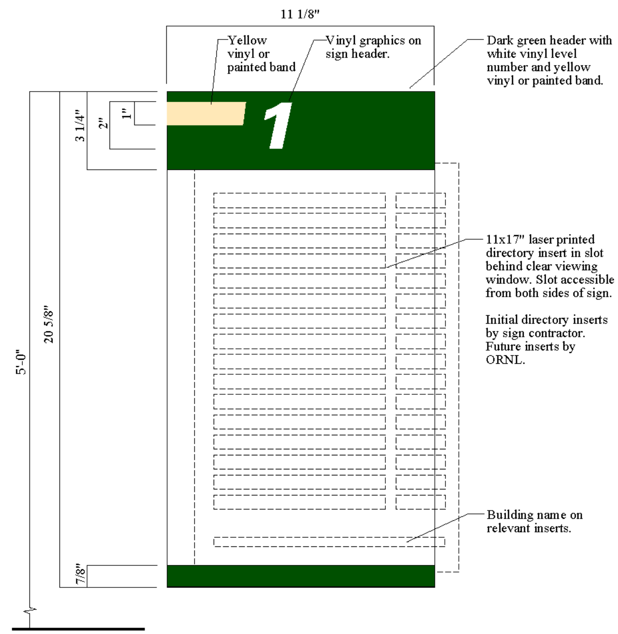
EC.5.1



Alternate Insert Layout with Plan 1/4"=1"

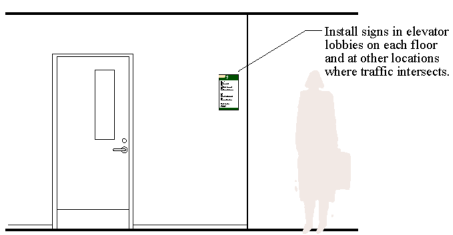


Typical Insert Layout 1/4"=1"



Sign Type 7 - Floor Directory 1/4"=1"

Dark green to match PMS 3302c
Yellow to match PMS 134c.
All finishes eggshell.

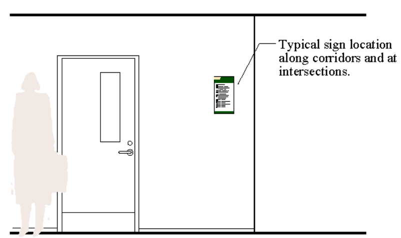


Typical Sign Location 1/4"=1'-0"

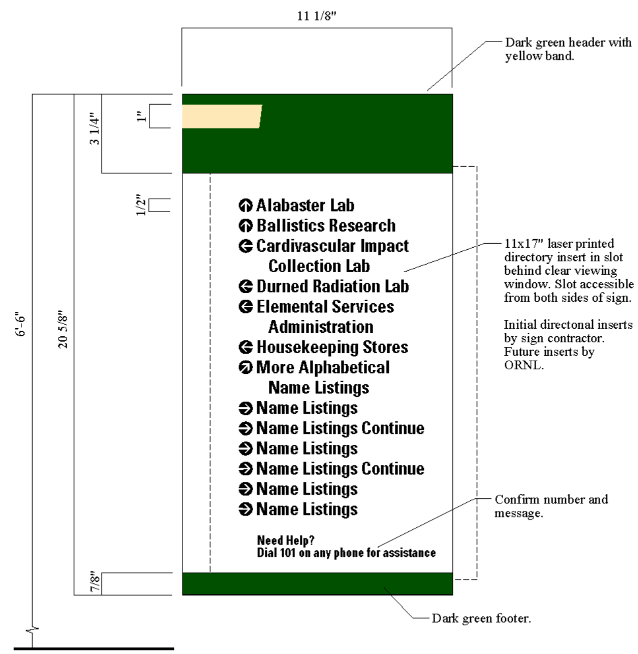
OAK RIDGE NATIONAL LABORATORY - SIGNAGE

EC.6

Full Size Message Sample *f.s.*



Typical Sign Location *1/4"=1'-0"*

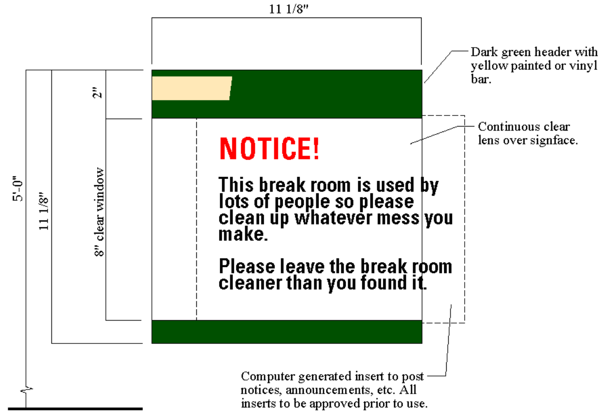


Sign Type 7.1 - Directional Signs *1/4"=1"*

Dark green to match PMS 3302c
Yellow to match PMS 134c.
All finishes eggshell.

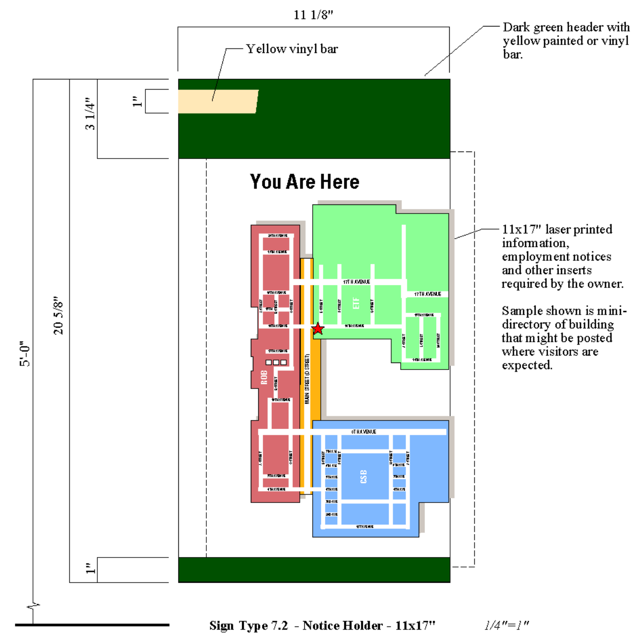
OAK RIDGE NATIONAL LABORATORY - SIGNAGE

EC.7



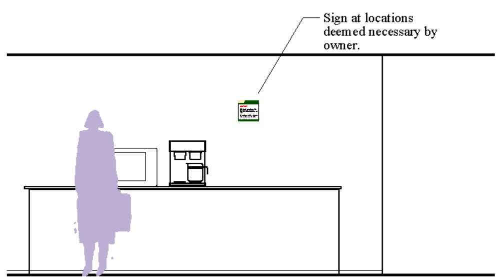
Sign Type 7.3 - Notice Holder - 8 1/2 x 11" *1/4"=1"*

Dark green to match PMS 3302c
Yellow to match PMS 134c.
All finishes eggshell.



Sign Type 7.2 - Notice Holder - 11x17" *1/4"=1"*

Dark green to match PMS 3302c
Yellow to match PMS 134c.
All finishes eggshell.

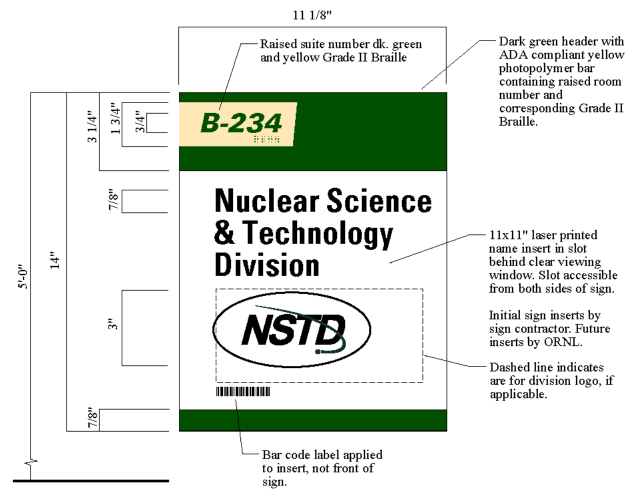


Typical Sign Location *1/4"=1'-0"*

OAK RIDGE NATIONAL LABORATORY - SIGNAGE

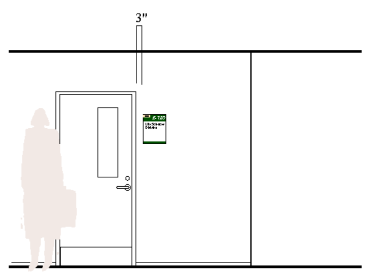
EC.8

Typical Sign Layouts 1/4"=1"

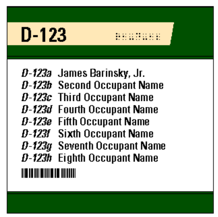


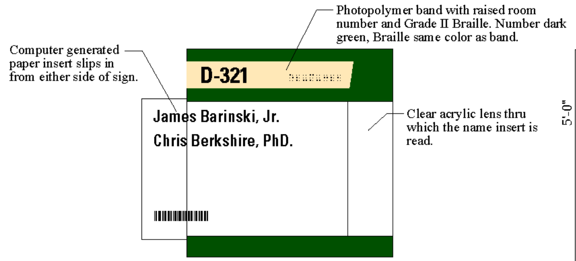
Sign Type 8 - Division Name Signs 1/4"=1"

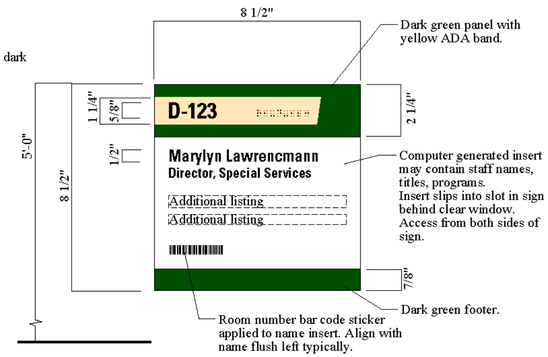
Dark green to match PMS 3302c
Yellow to match PMS 134c.
All finishes eggshell.



Typical Sign Location 1/4"=1'-0"





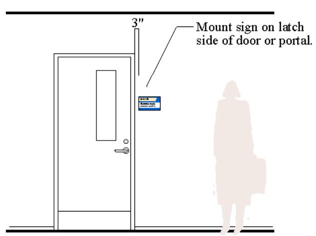


Sign Type 9.1 - Pod Identification - Staff *1/4"=1"*

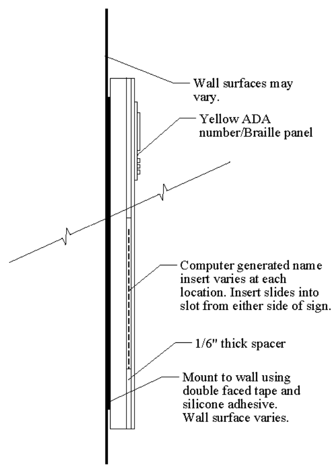
Sign may contain 3 - 8 names depending on positions along the corridor.

Sign Type 9 - Room Identification - Staff *1/4"=1"*

Dark green to match PMS 3302c
Yellow to match PMS 134c.
All finishes eggshell.



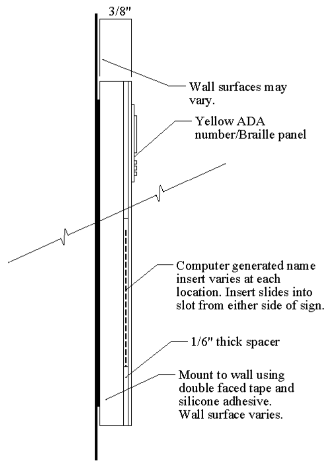
Typical Sign Location *1/4"=1"*



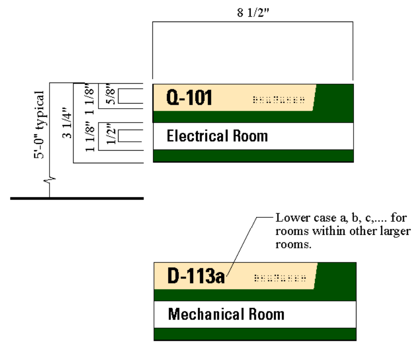
Typical Section *1/4"=1"*

OAK RIDGE NATIONAL LABORATORY - SIGNAGE

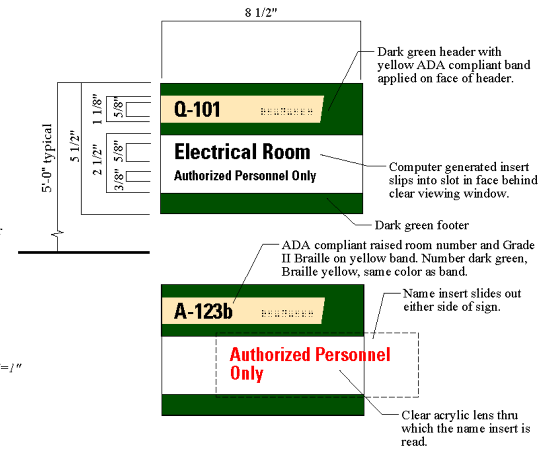
EC.10



Typical Section *1/4"=1"*
Sign type 10 shown, Option 1 similar. Option 2 similar but no slot for inserts.

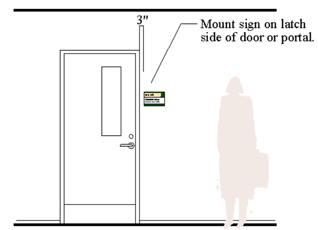


Sign Type 10.1 - Room or Staff Signs *1/4"=1"*
Smaller name insert, limited message area.

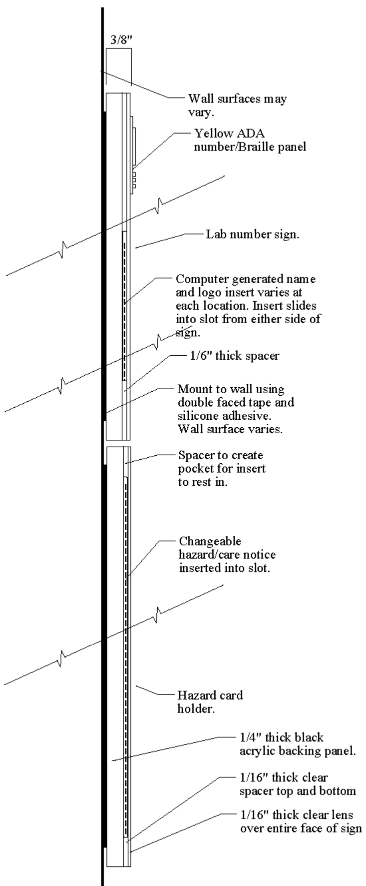


Sign Type 10 - Utility Room Signs *1/4"=1"*
Note: confirm with owner that no bar code is needed for fixed rooms such as electrical, mechanical rooms.

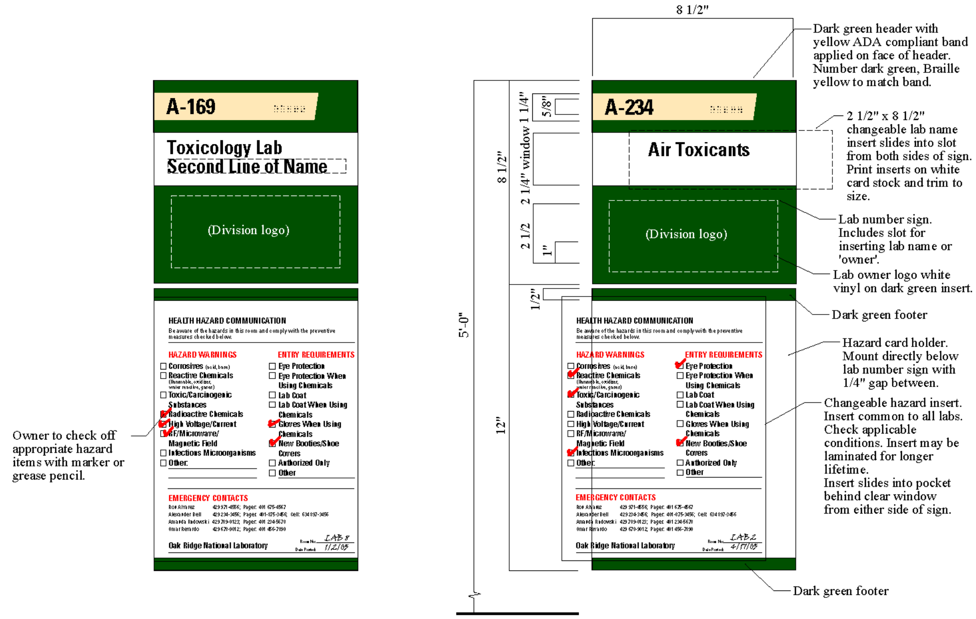
Dark green to match PMS 3302c
Yellow to match PMS 134c.
All finishes eggshell.



Typical Sign Location *1/4"=1'-0"*

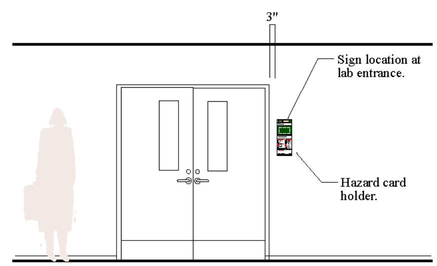


End View of Sign *f.s.*



Sign Type 11 - Lab Identification Signs *1/4"=1"*

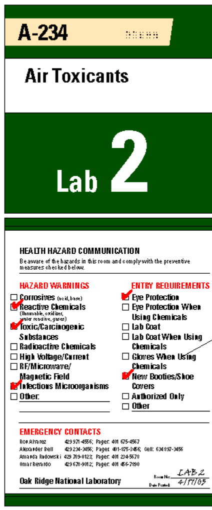
Dark green to match PMS 3302c
Yellow to match PMS 134c.
All finishes eggshell.



Typical Sign Location *1/4"=1"*
Install sign on latch side of door in single door entrance and to right of door set at double door entrances

OAK RIDGE NATIONAL LABORATORY - SIGNAGE

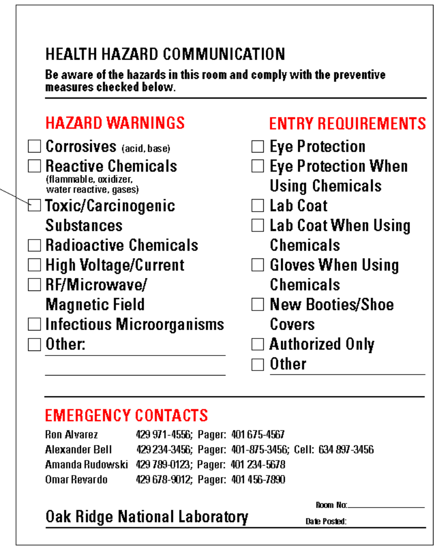
EC.12



Changeable health hazard insert. Insert common to all labs. Check applicable conditions. Insert may be laminated for longer lifetime.
Insert slides into pocket behind clear window from either side of sign.

Sign Type 11 - Lab Identification Signs *1/8"=1"*

Provide boxes so that lab owner can check appropriate safety precautions before inserting sign into slot of holder.



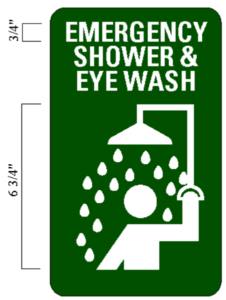
Size: 8 1/2" x 11"

Sign Type 11.1 Health Hazard Insert Card *half size*

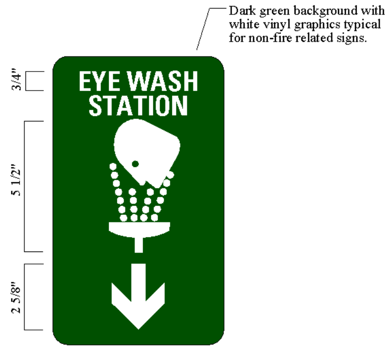
This layout shown for design/discussion purposes. Actual content of card to be determined by owner.
Clear laminate cards and trim so that laminate does not protrude out of sign slot. Confirm cards slide in and out of slot easily with no blockage of messages.

OAK RIDGE NATIONAL LABORATORY - SIGNAGE

EC.12.1



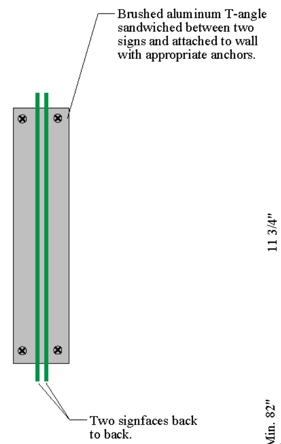
Sign Type 12.3 - Shower/Eyewash Station 1/4"=1"



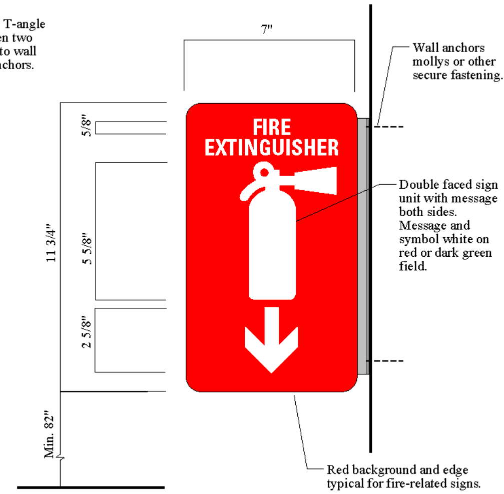
Sign Type 12.2 - Eyewash Station 1/4"=1"

Double faced sign unit with message both sides. Messages white on dark green field. Fire related signs red instead of dark green.

Confirm symbols and messages for each sign.



End View 1/4"=1"



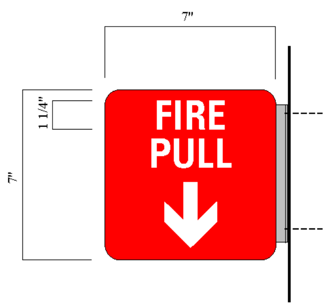
Sign Type 12 - Emergency Marker Signs 1/4"=1"

Perpendicular to wall over, or adjacent to, item indicated by sign message.

Two sign panels, back to back with T-angle sandwiched between. Provide spacer at outside edge of sign to maintain space between signfaces.

Sign contractor to confirm symbols for each sign.

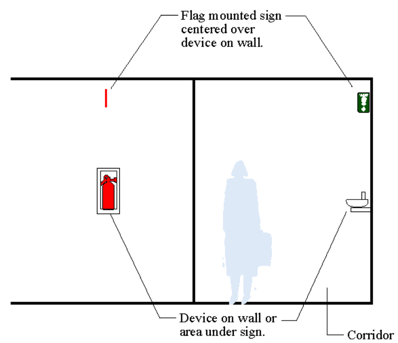
Dark green to match PMS 3302c
Red to match PMS 485c (fire signs only).
All finishes eggshell.



Sign Type 12.1 - Fire Pull Flag Signs 1/4"=1"
Perpendicular to wall over, or adjacent to, item indicated by sign message.

Two sign panels, back to back with T-angle sandwiched between. Provide spacer at outside edge of sign to maintain space between signfaces.

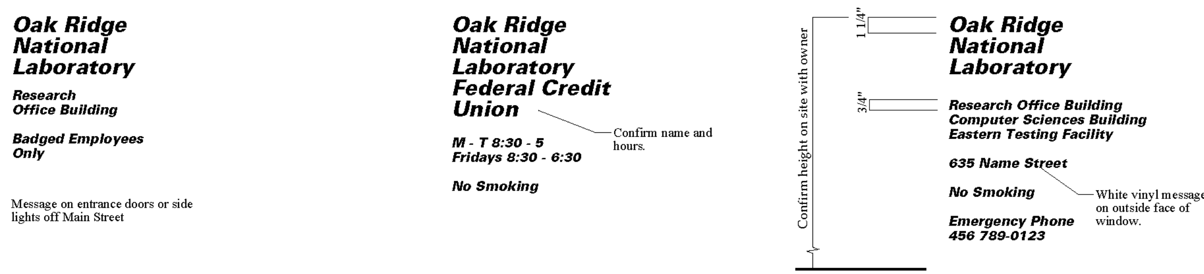
Sign contractor to confirm symbols for each sign.



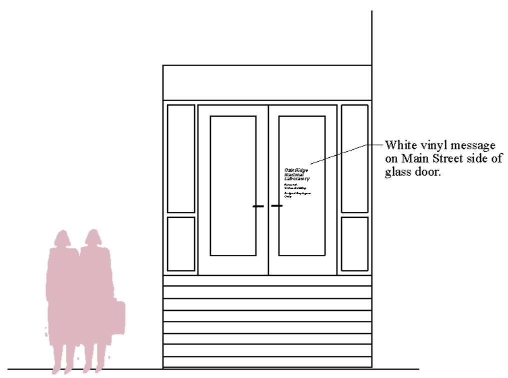
Typical Sign Locations 1/4"=1'-0"

OAK RIDGE NATIONAL LABORATORY - SIGNAGE

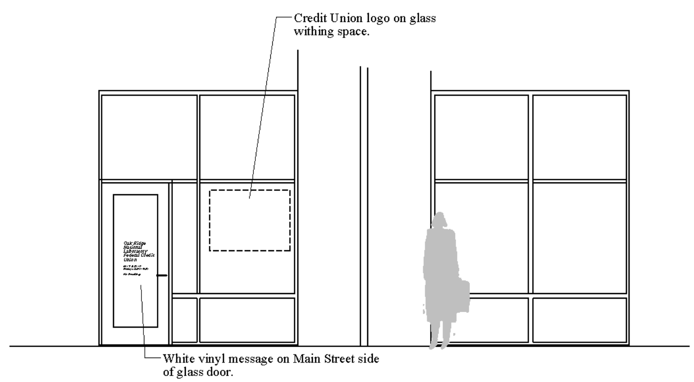
EC.13



Sign Type 13 - Vinyl Graphics at Entrances 1/8"=1"



Elevation at Stairs to ROB 1/4"=1'-0"



Elevation at Entrance to Credit Union 1/4"=1'-0"

OAK RIDGE NATIONAL LABORATORY - SIGNAGE

EC.14

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
1234567890!@#$%&*()+.,/;:''

Typestyle 1: Univers 65 Bold *n.s.*

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
1234567890!@#$%&*()+.,/;:''

Typestyle 1: Univers 67 Bold *n.s.*

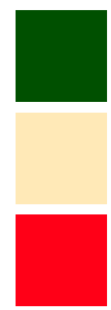
ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
1234567890!@#$%&*()+.,/;:''

Typestyle 1: Univers 75 Black Oblique *n.s.*

UT-BATTELLE
Oak Ridge National Laboratory

Project Logo
Artwork available.

Project Arrow *n.s.*
Arrow artwork available



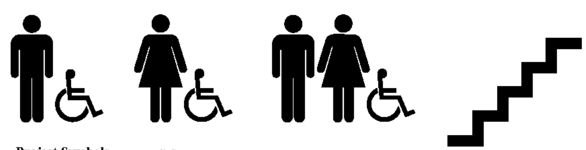
Dark Green
Match PMS 3302c
to match ORNL
green sign color.

Yellow
Match Devoe paint
#7751W 'Beach Grass'

Red (flag signs)
Match PMS 485c

Project Sign Colors *n.s.*
All finishes eggshell.

Arrow/Letter Spacing Typical
Always measure capital height on straigt/vertical
letter such as B, H, I.



Project Symbols *n.s.*
US DOT Symbol Signs used. Artwork available.

PART 5 -
END OF SECTION 01 84 23

SECTION 01 86 13 - FIRE PROTECTION

PART 1 - PROJECT REQUIREMENTS

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Based on the currently proposed size of the facility and operations within, the following project specific fire protection requirements and features are anticipated. The designer has the responsibility to confirm and/or alter the design approach as the design matures to maintain compliance with applicable project requirements, as accepted by the Company.

B. The design of this DOE facility shall satisfy the concepts for a Highly Protected Risk (HPR) facility as required in DOE Order 420.1C Change 2 and further detailed in DOE Standard 1066-2016. HPR is a term applied to property deemed to have a much lower than normal probability for loss by virtue of superior construction, special fire protection equipment and procedures, and management commitment to loss prevention. The requirements of the International Building Code (2012) (IBC) and applicable National Fire Protection Association (NFPA) codes and associated standards (such as NFPA 1 [*Fire Code®*], NFPA 101®, [*Life Safety Code®*], etc.) and references shall also be met but are considered minimum levels of protection and do not necessarily meet the HPR status. For example, the building shall be subdivided into multiple fire areas (horizontal and/or vertical) to limit the Maximum Possible Fire Loss (MPFL) in any one fire area to acceptable limits established by DOE.

C. Conflicts among the DOE Order, DOE Standard, the IBC, and NFPA Codes and Standards shall be evaluated, documented, and presented to the “corporate” AHJ (CAHJ) for Fire Protection and the ORNL Fire Protection Engineering (FPE) Group.

D. The facility occupancy classification and construction type shall be in accordance with the IBC based on the building area, height, and intended use. The NFPA occupancy classification shall also be determined, documented, and coordinated into the facility’s design solution. The occupancy classification and construction type shall be coordinated with the Architectural section. DOE O 420.1C requires that new facilities (non-relocatable) exceeding 5,000 sq ft of floor area be of Type I or Type II construction, as defined in the applicable building codes. For nuclear hazard category 1, 2, or 3 facilities, structural materials shall be noncombustible. See the Roles and Responsibilities Section for more information on the designer’s responsibilities.

E. Performance-based alternatives prepared under the direction of an FPE are an acceptable means of meeting applicable industry codes and standards.

F. The design of facilities, particularly those utilizing significant quantities of hazardous materials (e.g. wet chemistry labs), shall consider the use of multiple hazardous material control areas (HMCAs). The construction of the HMCA boundaries (horizontal and vertical) and supporting structure shall be reviewed and coordinated with the requirements of the IBC and NFPA 45, *Fire Protection for Laboratories Using Chemicals*. The number of HMCAs provided per floor and the selection of the boundaries that create the multiple HMCAs is subject to approval by the Company.

G. Building 3625 is currently protected by an automatic wet pipe sprinkler system as described in this section. The occupancy hazard classification as defined by NFPA 13, *Standard for the Installation of Sprinkler Systems*, is Ordinary Hazard, Group 1. The existing wet pipe sprinkler system shall be extended into the new addition to Building 3625.

H. An Edwards EST3 fire alarm signaling system is installed in Building 3625 as described in the technical requirements portion of this Section.

I. Roof system shall be a Factory Mutual Global Class I approved type and shall meet UL Class A fire exposure requirements.

J. Internally illuminated exit identification and directional signs should use LED type illumination. Emergency light units and exit signs with internal back up power shall be a self-diagnostic type, if provided.

K. If provided, emergency power provisions shall comply with the requirements of NFPA and IBC requirements, including NFPA 110, *Standard for Emergency and Standby Power Systems*, NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems* and other references.

L. Modifications to the underground water supply system shall be of the looped grid type providing multiple flow paths, with sectional valves installed and arranged to provide alternate flow paths to any point in the system. Fire mains shall be at least 8 inch diameter, except those supplying a single fire hydrant or extensions of existing smaller mains. Water supply mains shall be sized to supply the largest expected fire suppression flow demand plus the largest potable water domestic demand. Residual sprinkler system pressure requirements shall be included in the design. The design and installation of all combined potable and fire water supply system components shall be in accordance with the requirements of the applicable NFPA and IBC requirements, including NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*. Also coordinate with the Utilities Section covering underground piping.

M. Portable fire extinguishers shall be located for type, quantity and placement by the designer in accordance with NFPA and IBC requirements, including NFPA 10, *Standard for Portable Fire Extinguishers*.
   1. The designer shall determine if any facility hazards require specific types or quantities of portable fire extinguishers. The hazard(s) to be protected, type(s), locations, and quantity of portable extinguishers by type shall be indicated on the documentation described in this section. Clean Guard fire extinguishers should be installed in the new microscope lab.
   2. Using project funds, the Company will provide the required portable fire extinguishers.

3. Recessed wall cabinets shall be installed where appropriate to accommodate portable fire extinguishers for areas with Ordinary hazards. Cabinets must be large enough to fit an extinguisher that is 20.5” tall, 8.5” handle and nozzle width and 5.75” diameter and should not have locking latches.

N. Fire department access shall be provided in accordance with NFPA and IBC requirements Section 01 89 00.2 Fire Apparatus Access, and as accepted by the Company.
   1. Direct access to fire department connection(s) and the fire alarm system control panel(s) shall be provided.
   2. Keyed access as specified by Company shall be provided to all areas and spaces of the facility for emergency response forces.

O. The design of the roads and parking areas adjacent to the new facility shall accommodate access by fire department vehicles. The layout of roadways adjacent to the building shall be in compliance with the IBC / International Fire Code (IFC) and NFPA 1141, *Standard for Fire Protection Infrastructure for Land Development in Wildland, Rural and Suburban Areas.*

P. All ventilation dampers (fire, smoke, combination) and duct smoke detection components and functions shall be in accordance with the NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilation Systems*. In-duct-type smoke detectors shall be photoelectric-type. The design and installation of the smoke detectors shall be in accordance with the current edition of NFPA 72®, *National Fire Alarm and Signaling Code* and shall be connected to the building fire alarm signaling system.

Q. The building’s electrical system shall be designed and installed in accordance with the current edition of NFPA 70®, the *National Electrical Code®*. Interior electrical transformers shall be dry-type unless documented relief is provided by the AHJ. Exterior transformers shall be Factory Mutual (FM)-approved containing FM-approved transformer fluid or otherwise properly protected and/or located.

R. Lightning protection systems shall be considered for all buildings. A risk assessment using the guide in Appendix H of NFPA 780, *Standard for the Installation of Lightning Protection Systems* shall be prepared to determine the risk of loss due to lightning. Where required, lightning protection systems shall comply with NFPA 780.

S. Seismic bracing for sprinklers shall be provided based on the seismic requirements found in the Structural section. Installation of seismic bracing for sprinklers shall be in accordance with NFPA 13. All sprinkler systems should be designed with a seismic importance factor of 1.5 unless otherwise specified by ORNL FPE.

T. As required by Section 12.7.5 of NFPA 1 and/or Section 712.4.1.1.2 of the IBC, through penetrations and membrane penetrations shall be protected by an approved through-penetration firestop system installed and tested in accordance with ASTM E814 or UL 1479. Drywall compound shall not be accepted for sealing either through-penetrations or membrane penetrations in a fire resistance rated barrier. All firestop caulk and putty shall be the color red with the exception that elastomeric sprays and sealants for fire rated construction joints may be the color white. Firestop sealant requirements should be written for compliance with the product requirements of Specified Technologies Inc. (STI) and/or equal. The General Contractor shall determine the manufacturer’s brand of firestop materials to be used on the project, and all project subcontractors shall be required to use the manufacturer's products selected by the general contractor. In all applicable shop drawing submittals, the contractor shall be required to submit on the drawings an appropriate Firestop UL System Assembly File Number and Detail for each type of fire barrier penetration to be made by their system and/or equipment. Installation of firestop sealants shall be completed as soon as possible by the responsible contractor before access to penetrations becomes obstructed by other systems and equipment that is installed by other contractors

U. Fire rated door assemblies and other fire barrier opening protection equipment shall be inspected and tested in accordance with NFPA 80, *Standard for Fire Doors and Other Opening Protectives*. Smoke door assemblies shall be inspected and tested I accordance with NFPA 105, *Standard for Smoke Door Assemblies and Other Opening Protectives.*

V. Commissioning and integrated system testing of all fire protection and life safety systems shall be conducted in accordance with NFPA 3, *Standard for Commissioning of Fire Protection and Life Safety Systems* and NFPA 4, *Standard for Integrated Fire Protection and Life Safety System Testing*.

PART 2 - CODES AND STANDARDS

2.1 CODES, STANDARDS, AND SPECIFICATIONS

A. DOE requirements: DOE Order 420.1C and DOE Standard 1066-2016.

B. Work Smart Standards (WSS) referenced in Section 01 41 00 apply to this Section.

C. The design and construction shall comply with the following commercial requirements:

1. International Building Code, (IBC, 2012 (Exceptions: Replace all references to the ICC Electrical Code with the NFPA 70® *National Electrical Code®*, latest edition; All appendices; See additional exceptions identified in the WSS ID Team Report, Attachment B IBC matrix).
2. International Fire Code, (IFC), 2012 (Include Appendix B through I as reference only; Exception: Appendix A – Board of Appeals) Note: Per the WSS Implementation Matrix for the IFC: The IFC will be used primarily for the coordination and management of Hazardous Materials Management requirements such as establishing HMCAs (per the IBC) and establishing Maximum Allowable Quantities (MAQs) for Chemical inventories for the IBC-related Control Areas. All fire code requirements must meet and/or be coordinated with NFPA 1 and NFPA 101®. Conflicts shall be resolved by the AHJ.
3. International Fuel Gas Code, (IFGC), 2012. (Include Appendix B through I as reference only).
4. International Mechanical Code, (IMC), 2012 (Exceptions: All Appendices).
5. International Plumbing Code, (IPC), 2012 (Include Appendix B through G as reference only).

D. The design and construction shall also comply with the following NFPA requirements:

a. NFPA 1, *Fire Code®*. (NFPA 1 is the predominate Fire Code for ORNL Facilities)

b. NFPA 3, *Standard for Commissioning of Fire Protection and Life Safety Systems*
c. NFPA 4, *Standard for Integrated Fire Protection and Life Safety System Testing*
d. NFPA 10, *Standard for Portable Fire Extinguishers*
e. NFPA 13, *Standard for the Installation of Sprinkler Systems*
f. NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*
g. NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*
h. NFPA 70®, the *National Electrical Code®*
i. NFPA 72®, *National Fire Alarm and Signaling Code*
j. NFPA 80, *Standard for Fire Doors and Other Opening Protectives*
k. NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilation Systems*
l. NFPA 101®, *Life Safety Code®*
m. NFPA 105, *Standard for Smoke Door Assemblies and Other Opening Protectives*
n. NFPA 110, *Standard for Emergency and Standby Power Systems*
o. NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems*
p. NFPA 780, *Standard for the Installation of Lightning Protection Systems*
q. NFPA 1141, *Standard for Fire Protection Infrastructure for Land Development in Wildland, Rural and Suburban Areas*
r. All other NFPA Codes and Standards (except NFPA 5000), as applicable as determined by the Authority Having Jurisdiction (AHJ).

E. Engineering Standards
1. See ProjectWise.

F. Other.

1. Conflicts between the DOE Order, NFPA codes and standards (including DOE Standard 1066) and the applicable building code must be resolved as follows:

    a. Requirements of the DOE Order 420.1C will take precedence over all NFPA and building code requirements and are subject to the relief requirements specified in the Order.

    b. Conflicts among the DOE Order, DOE Standard, the IBC, and NFPA Codes and Standards shall be evaluated, documented, and presented to the "corporate" AHJ for Fire Protection and the ORNL Fire Protection Engineering (FPE) Group.

2. Alternative approaches to NFPA and IBC requirements shall be presented to the fire protection CAHJ for approval before execution, with adequate time allowed for review and consideration. Documentation of the modification(s) shall be included in the required documentation. Documentation can be accomplished by one of the following based on the issue and at the discretion of the CAHJ:
    a. Request for Fire Protection Engineering Approval via Form ORNL-1025,
    b. FHA or
    c. General communication (email chains, letters, report forms, etc.)

3. Performance-based alternatives must be documented in the preliminary FHA and approved by the CAHJ before implementing.

4. Modifications of the intent of the DOE, NFPA and IBC requirements shall be presented to the Company for acceptance before execution, with adequate time allowed for review and consideration. Documentation of the modification(s) shall be included in the required documentation.

5. Design solution requirements shall be based on the edition of the codes and standards in effect at the time the facility design is accepted. These codes and standards, and the edition used, shall be documented and shall establish the "Codes of Record."

6. As-built drawings and documentation, consisting of the code footprint and drawings and documents required by the codes and standards for fire protection systems, shall be provided to the Company before facility acceptance.

7. A drawing cabinet shall be installed inside of the facility as required by both NFPA 13 and NFPA 72. The Company prefers that a single drawing cabinet be installed for both the fire alarm and sprinkler systems. The fire alarm and fire sprinkler contractor should coordinate between each other and with FPE on the size necessary and the final location.

2.2 AUTHORITY HAVING JURISDICTION (CODE COMPLIANCE REVIEW AND ACCEPTANCE AUTHORITY)

A. Pertaining to subjects included in this section, the Company representative for code compliance design review and acceptance, as generally specified in NFPA 1, NFPA 101®, and the International Building Code Chapter 1, is ORNL FPE. Non-fire protection related issues may require involvement by the ORNL Chief Engineering or subject matter experts such as a Facilities Development Division electrical engineer, etc.

PART 3 - TECHNICAL REQUIREMENTS

3.1 FIRE PROTECTION SYSTEM DESIGN AND INSTALLATION REQUIREMENTS

A. Qualifications.

1. All fire protection design packages, including fire suppression, fire detection and fire alarm drawings, specifications, and calculations, shall be prepared by a Tennessee licensed engineer in accordance with applicable state law, rules, regulations, and the guidance and policies promulgated by the Tennessee Board of Architectural and Engineering Examiners. Design and installation activities of all fire protection systems shall comply with the State of Tennessee requirements for such systems, including contractor licensing and documentation. Designs shall be submitted to the Company for review and acceptance. Fire Protection System design submittals shall comply with the applicable I-Codes and references, NFPA 1, Fire Code and references, the

submittal requirements of this section, and the requirements of the applicable codes and/or standards for the particular type of system.

2. Fire Sprinkler Systems.
   a. All sprinkler system designs and submittals shall be consistent with the State of Tennessee "Standard of Care." The design shall be sealed, signed and dated by a registered engineer (licensed in the State of Tennessee) competent in the design of sprinkler systems as required by this section. Sprinkler shop drawings submitted by a licensed sprinkler system contractor shall be coordinated with and approved by the registered engineer.
   b. All fire sprinkler system installations shall be performed by a fire protection sprinkler system contractor licensed as required by this section. All sprinkler systems shall be installed under the supervision of a competent registered engineer or NICET Level III engineering technician.
3. Fire Detection and Alarm Systems.
   a. All fire alarm system designs shall be sealed, signed, and dated by a registered engineer (or a NICET Level IV certified fire alarm designer) competent in the design of alarm systems as required by this section.
   b. All system installations shall be performed by a fire protection alarm system contractor licensed as required by this section. All fire detection and alarm systems shall be installed under the supervision of a competent registered engineer or NICET Level II engineering technician.

B. The design of fire sprinkler systems shall comply with NFPA 13 *Installation of Sprinkler Systems* and the following additional requirements.
   1. The automatic sprinkler system is a wet pipe system.
   2. The extension of the existing system shall be hydraulically designed using no less than the Ordinary Hazard, Group 1 Area/Density curve. Per DOE requirements Light Hazard designs are not acceptable. Adequate allowance shall be provided for the installation of required backflow prevention devices.
   3. Seismic bracing for sprinklers shall be provided as required by seismic classification.
   4. Fire sprinklers shall be considered to have a seismic importance factor of 1.5, unless otherwise specified by ORNL FPE.
   5. Backflow prevention is provided be provided on the existing system.
   6. The hydraulically designed automatic sprinkler system shall contain no pipe size smaller than the sizes specified in the Ordinary Hazard Pipe Schedule design approach.
   7. Sprinkler protection shall be installed in all areas and spaces per the applicable codes/standards and as specified and accepted by the Company.
   8. Sprinklers shall be Tyco, Victaulic or Viking brand unless otherwise specified by ORNL FPE.
   9. Sprinklers shall be ordinary response type, contain no O-rings in the operating design, have a current date, and use a frangible bulb operating element (preferable) or fusible link operating element when condition necessitate.
   10. All piping shall be at least schedule 40 steel. All piping shall meet the material specifications and installation requirements in the applicable codes and standards.
   11. Non-metallic pipe and fittings are not to be used unless specifically authorized by the Company.
   12. The sprinkler system design and installation shall coordinate as needed to electronic supervision of the system supply PIV, OS&Y control valve at the riser, and alarm bypass (test) valve.

13. Butterfly valves shall be Nibco or Globe brand unless otherwise specified by ORNL FPE.
14. Sprinkler water supply line shall be no smaller than 6-inch diameter pipe, and no smaller than the system riser size. The sprinkler supply shall be independent of potable water supplies.
15. The sprinkler system riser is located in a dedicated room in the southeast corner of Building 3625.
16. Valving and associated piping shall be provided as necessary to facilitate the forward flow test requirements of NFPA 13 for all backflow prevention devices at required system demand.
17. Signage on exterior of the facility shall be provided to readily identify fire department connections.
18. Acceptance testing shall be witnessed by a representative of the Company and shall be in accordance with the applicable codes and standards for the type of system. Required documentation shall include marked-up drawings at acceptance. Accurate as-built drawings shall be completed and submitted electronically to the Company upon completion of the job.
19. Pipe and components shall be labeled in accordance with applicable codes and standards. Sprinkler pipe located in an area with other pipes or systems in such a way that the sprinkler pipe is not readily identifiable shall be primed and painted red (chip 21105).
20. Signage shall be provided to clearly identify all valves including control, drain, and test connection valves. All control valve signs shall identify the portion of the building served. A general information sign shall also be provided as required by NFPA 13 Section 25.6 to include information used to determine the design basis and information relevant to the inspection, testing, and maintenance requirements for the sprinkler system.

C. The design of the fire detection and alarm system shall comply with NFPA 72®, *National Fire Alarm and Signaling Code* and the following additional requirements:
1. A fully addressable fire alarm control panel is already provided for Building 3625. The fire alarm control panel is an Edwards Systems Technology (EST) model EST3 Multiplex Fire Alarm System, installed in a location accepted by the Company. Design and installation shall be in accordance with the applicable codes and standards, and the additional requirements in the Electrical section and this section. The fire alarm shall be provided and installed in accordance with Technical Specification Section <283113>.
    a. The primary purposes of the system shall be to provide local alarm notification, both audible and visual to facility occupants and transmit system signals to the ORNL emergency response forces.
2. Manual fire alarm pull stations shall be provided adjacent to each designated required exit. The manual pulls shall be recessed and shall be identified with signs mounted above the device.
3. All notification appliances shall be LED-type. If LED-type are not available for exterior or hazardous areas, other types may be utilized.
4. Multi-sensor detectors (photoelectric and heat detecting) shall be UL-listed for use with control equipment provided.
5. At a minimum, multi-sensor detectors are required to be installed in the microscope rooms and control rooms.

6. Duct smoke detectors shall also be provided as required by applicable codes and easily accessible for testing. Remote test stations (SD-TRM, SD-TRK, etc.) shall not be installed or utilized for testing. If duct smoke detector is located out-of-sight (e.g., above a drop ceiling), SIGA-LED or similar to be installed for remote indication of detector condition.
7. An access door for testing the in-duct smoke detection shall be provided directly upstream of the installed detector. Alternate means to accomplish testing can also be provided with approval from ORNL FPE.
8. The fire alarm system installer shall coordinate as needed to ensure efficient and effective tie-ins of sprinkler system fire alarm and supervisory connections.
9. All fire alarm wiring shall be run in dedicated, metallic raceways; no other wiring shall be allowed in the fire alarm raceways, enclosures, or junction boxes (except interfaces to devices and circuits controlled by the fire alarm system). Conductors supplying AC power to the fire alarm system shall not be installed in the same raceways, enclosures, or junction boxes as fire alarm signal circuits. All fire alarm junction box covers shall be red in color for ease of identification. Also, mark all fire alarm conduit every 20 ft. with red tape or paint to make said conduit readily identifiable to Company personnel after installation.
10. Where a fire alarm system must interface with other systems, such as motor control or scram circuits, 24-V DC interface relays shall be provided in a separate enclosure to isolate the fire alarm system from the devices being controlled. The interface relays' contact ratings and configurations shall be specified as required for the application.
11. Where a fire alarm system interfaces with other systems for the purpose of fire control, such as an air conditioner or electrical power shutdown circuit, a means shall be provided to test the fire alarm system without affecting the other systems. This is usually accomplished by installing one or more supervised key switches in lockable enclosures (e.g., FACP) to disable shutdown functions of said other systems. The method used shall have the approval of the ORNL Electrical Engineering and the FPE Departments.
12. Interface equipment (modules, tamper switches, flow and/or pressure switches, etc.) shall be indicated on design drawings and provided as necessary to monitor components associated with the sprinkler system. In addition, duct smoke detectors, monitor modules, control modules, shall be provided as required by code to interface and manipulate the air handling equipment.

D. Acceptance testing shall be witnessed by a representative of the Company, and shall be in accordance with NFPA 3 and 4 as well as the applicable codes and standards for the type of system (e.g. NFPA 72 for fire alarm systems). Required documentation shall include marked-up drawings at acceptance. Complete as-built drawings (CAD) shall be completed and submitted to the Company upon completion of the job.

3.2 CALCULATIONS

A. Hydraulically designed sprinkler calculations shall be provided in accordance with NFPA 13. The available water supply is based on actual flow test data. Flow test results on the southside of Building 4515 at Test Hydrant 03-46 while flowing Hydrants 03-40 and 03-47 are as follows: Static Pressure 90 psi, Residual Pressure 78 psi, Flow rate 2,600 gpm. For design purposes, the static and residual pressures shall be reduced by at least 10% or 10 psi, whichever is greater, to provide a margin of safety. This safety margin shall account for potential degradation of the underground water distribution system over the life of the facility.

B. Fire detection and alarm system power supply calculations for both primary and secondary (battery) shall be provided in accordance with NFPA 72®. A 20 percent margin for additional field devices (inputs and notification appliances) shall be provided in the design and calculations. Voltage drop calculations shall be provided for all notification alarm circuits in accordance with NFPA 72 and UL 1971. These calculations will start with a maximum of 20.4 V per UL 1971

3.3 DOCUMENTATION

A. Fire protection systems design, calculations, acceptance testing, drawings and other as-built documentation shall be in accordance with the applicable NFPA and IBC requirements, the submittal requirements of this section, the requirements of the applicable codes and/or standards for the particular type of system, and State of Tennessee requirements for such systems. The following specific documentation is required as a minimum.
   1. Fire sprinkler submittals shall include:
      a. Calculations, drawings, and equipment data as required by NFPA 13.
      b. Sprinkler layout and piping arrangement.
      c. Sprinkler riser details including water supply tie-in.
      d. Elevation views as necessary for clarity.
   2. Fire detection and alarm submittals shall include:
      a. Calculations, drawings, and equipment data as required by NFPA 72®.
      b. Device and circuit layout including device logical address in coordination with the riser and input/output matrices.
      c. Riser drawings.
      d. Input/output matrices.
      e. Fire alarm control panel detail drawings.
      f. Fire alarm interface details.
   3. A drawing cabinet shall be installed inside of the facility as required by both NFPA 13 and NFPA 72. The Company prefers that a single drawing cabinet be installed for both the fire alarm and sprinkler system drawings. The fire alarm and fire sprinkler contractor should coordinate between each other and with FPE on the size necessary and the final location.

B. The “non-structural” aspects of facility fire protection, occupant safety, and code implementation and compliance shall be documented for design review, for documentation of changes, and for as-built documentation as described below:
   1. Single “code footprint” sheet for each floor.
   2. Graphic, contextual, schematic floor plan showing only the code compliance aspects of the design, containing the information described in this section.

C. Minimum requirements for the “code footprint.”
   1. Schematic floor plan shall include:
      a. Graphic bar scale.
      b. North indicator.
      c. Complete floor plan.

d. All permanent partitions taller than 6-ft.
e. Each room and space clearly labeled with plain text, key notes, or legend.
f. Occupant load for assembly areas and total for each floor.
g. Stair and shaft enclosures with identification of ratings and opening protectives.
h. Rated corridors with identification of ratings and opening protectives.
i. Occupancy and area separations.
j. Horizontal exit arrangements, exit passageways, and smoke compartments.
k. Designated required exits and their capacity.
l. Fire department connections and access to facility.
m. Access to property and buildings.
n. Power and fuels shut-off locations.
o. Small scale site plan.
p. Distances to exposures and "property" lines.
q. Grade elevation at each building corner.
r. Any special hazards or conditions.
s. Location of any planned future additions.

2. Narrative information on the code footprint shall include:
   a. Project purpose (new construction, addition, etc).
   b. Codes of record, including edition.
   c. Other significant requirements, including source.
   d. Building location.
   e. Facility name and owner.
   f. Date developed, and space for revision dates.
   g. Designer's information (name, address).
   h. Designer's seal.
   i. ORNL Fire Department identified as emergency response organization. [Note: for ORNL facilities located outside the Oak Ridge Reservation, the applicable emergency response organization shall be identified.]
   j. Occupancy type(s).
   k. Construction type.
   l. Total floor area of each occupancy, with actual design area compared to allowed area, and explanation of any increases.
   m. Actual building height/stories, with actual height/stories compared to allowed, and explanation of any increases.
   n. Structural fire ratings.
   o. Identification of fire suppression systems and areas covered.
   p. Identification of fire alarm signaling systems and areas covered.
   q. Emergency lighting provisions.
   r. Any smoke management provisions.
   s. Any special systems or protection approaches.
   t. Hazardous materials identified by hazard class, storage areas, use areas and systems, both inside and outside the building envelope as needed.
   u. Water supply information for fire protection.
   v. Alternative design, modifications, methods, systems, or construction to document rationale and acceptance.

D. The code footprint shall be developed as early in the initial design process as possible, and shall be the code compliance review submittal. It shall be the documentation method for any changes which involve the non-structural code aspects of the design. It shall be used to track and communicate design changes, for review submittals, and to capture and portray the as-built facility code compliance status. It shall be modified as needed during the design and construction process to accurately reflect current facility design status, and shall be part of the required as-built documentation.

3.4 REQUIREMENTS FOR REVIEW SUBMITTALS

A. Formal design reviews shall be performed by the Company, and documentation of acceptance of the reviewed design will be accomplished before any work involving the reviewed material begins. The reviews will be conducted on submittals which meet the Company's requirements as follows:
   1. Code footprint drawings for general non-structural code compliance as described in this section.
   2. Plans and specifications for fire protection systems meeting the documentation requirements of the pertinent code and/or standard.

3.5 ROLES AND RESPONSIBILITIES

A. The designer shall be responsible for compliance with, and coordination of, the requirements in the applicable DOE Orders and referenced DOE Standards, the applicable building code, and applicable NFPA Codes and Standards and referenced material, regardless of whether or not any reviews are conducted, and regardless of any acceptance or rejection of any review items or elements. It shall be the designer's role to evaluate any alternative or equivalent methods, materials, or systems proposed for use in the design, and the designer shall present justification documentation to the Company for acceptance according to the documentation requirements in this section. Any features or elements of the design solution which meet the intent of the code and standards, and are accepted by the Company as an appropriate alternative or equivalent approach to compliance, in accordance with DOE, NFPA, and/or the IBC, shall be documented according to the documentation requirements in this section.

B. Design, installation, testing, and acceptance of fire protection systems shall be performed by entities meeting the requirements of Tennessee state law concerning licensing and practice standards for work involving fire protection systems. Compliance with the applicable NFPA codes, standards, and references and applicable I-Code requirements shall be demonstrated in design, installation, testing, and acceptance of fire protection systems.

END OF SECTION 01 86 13

SECTION 01 86 16 – FACILITY PLUMBING AND PROCESS PIPING

PART 1 - PROJECT REQUIREMENTS

1.1 SUMMARY

A. Authority Having Jurisdiction, AHJ, is the Company for projects located on DOE property; otherwise the AHJ is the Local / State Regulatory Agency.

B. Facility Plumbing and process piping design and installation shall provide the microscope manufacturers' required services.

C. Any heating water, chilled water, cooling tower water, and process cooling water systems shall be designed to minimize dead legs. Cleaning and flushing shall be per ORNL Specification Section 33 61 24. After cleaning and flushing these systems shall remain circulating and their chemical treatment shall be monitored.

D. Provide header isolation valves for maintenance and leak repair. At a minimum, provide isolation valves at each floor and at each branch header connection. Where long runs exist on a single floor provide additional isolation valves and crossovers if necessary. In no scenarios shall a piping system outage in one laboratory cause an outage in an adjacent laboratory.

E. Chilled Water is supplied to 3625 via a 6" buried pipe from Building 4509. Seller to verify the current building requirements for building and process cooling loads, additional new facility loads and install additional pipes or larger supply and return pipes from 4509.

F. If the requirements listed in this section conflict with other sections, the most stringent requirements shall be provided.

PART 2 - CODES AND STANDARDS

2.1 DESIGN STANDARDS

A. Work Smart Standards referenced in Section 01 41 00 apply to this Section.

B. Additional Standards/Guides.
   1. Guiding Principles for Sustainable Federal Buildings
   2. Economic Insulation Thickness Guidelines for Piping and Equipment.
   3. Underwriters Laboratories (UL).
   4. Factory Mutual (FM).
   5. ASHRAE 90.1, Energy Standard for Buildings except Low-Rise Residential Buildings.
   6. ISEA Z358.1, Emergency Eyewash and Shower Equipment.
   7. AWWA M41, Manual of Water Supply Practices, Ductile Iron Pipe and Fittings.
   8. ANSI A 13.1 Scheme for Identification of Piping Systems.

9. ANSI A 17.1 Elevator Code.
10. Foundation for Cross-Connection Control and Hydraulic Research.
11. Americans with Disabilities Act, ADA.
12. American Concrete Institute (ACI) 350.5, Specifications for Environmental Concrete Structures
13. UL-142 Aboveground Flammable Liquid Storage Tanks
14. NFPA 30 Flammable and Combustible Liquids Code
15. NFPA 33 Standard for Spray Application Using Flammable or Combustible Materials

C. ORNL Engineering Standards
1. ES-MECH-G-01 Mechanical Systems 851 Codes

PART 3 - TECHNICAL REQUIREMENTS

3.1 GENERAL

A. Code/Design
1. All systems shall be designed to codes outlined in Engineering Standard ES-MECH-G-01, Mechanical Systems 851 Codes.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Piping systems shall be tested per the hydrostatic testing requirements of listed code reference based upon the design pressure.
4. Pressurized and/or heated tanks and vessels shall be designed, fabricated, inspected, and stamped in accordance with the requirements of ASME Boiler and Pressure Code, Section VIII. Provide National Board Registration for all Section I and VIII boilers/vessels.
   a. ASME Pressure Vessels shall be inspected after installation by the AHJ. Inspection shall be scheduled prior to placing the vessel in service.
5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. Piping systems shall be tested per the hydrostatic testing requirements of listed code reference based upon the design pressure.
7. Piping systems shall be sized to meet their intended load, plus 10% spare capacity unless otherwise specified.
8. Provide all utility connections and services required for a complete and operational building.
9. Capacities and sizes of pipes, pumps, and other equipment shall be determined by performing calculations based upon the requirements noted on Room Data Sheets and other building area requirements contained herein. An electronic copy of the calculations (pdf file format) shall be provided. The calculations shall be sealed by a Professional Engineer licensed in Tennessee for record purposes. Calculation could include:
   a. Engineered vent system calculations
   b. Water service size calculations
   c. Waste and vent fixture calculations

d. Hydraulic calculations for sizing the potable and process cold and hot water systems
e. Storm water and roof drain calculations
f. Safety shower and eye wash piping sizing calculations
g. Air compressor, tank, and system sizing
h. Lab vacuum pump, tank, and system sizing
i. Relief valve sizing
j. Pump sizing calculations
k. Pipe sizing calculations, all hydraulic systems
l. Heat exchanger calculations
m. Expansion tank calculations

10. Insulation
    a. Insulation for piping systems and auxiliary components and equipment shall minimize energy loss, prevent condensation, protect from freezing and provide safe surface temperatures. The Economic Insulation Thickness Guidelines for Piping and Equipment prepared by the North American Insulation Manufacturers Association (NAIMA) shall be the basis for determining insulation thickness.
    b. Pipe hangers and supports shall not penetrate the insulation on chilled water lines.
    c. Site Standards
        1) Use of fiberglass insulation must be approved by the Company
        2) Asbestos or asbestos-containing materials shall not be used.
11. Supports/Hangers
    a. Piping systems, components and equipment shall be designed and anchored in accordance with Section 01 82 00, Structural.
    b. Support spacing shall not exceed spans given per ASME B31 Code series.
    c. Pipe hangers and supports shall not penetrate the insulation on chilled water lines.
12. Corrosion Protection
    a. Protect piping against corrosion either by natural resistance of the material or by other protective measures, see Section 01 86 26, Electrical for cathodic protection.
13. If new building or other permanent structures are to be built above existing underground mechanical utilities, the underground utilities shall be relocated.

B. Metering and Data Collection
1. The Energy Management and Control System shall monitor the domestic and process water, chilled water, and compressed air.
2. A single Modbus-to-Ethernet gateway may be used to support all devices and an RS-485 multidrop network configuration may be used between devices.

C. Reliability/Maintainability
1. Systems for critical applications shall be designed with sufficient backup so that the failure of any one component does not preclude operation of the system.
2. Equipment arrangements shall allow for all maintenance access requirements, component removal space, lay down areas and any other clearances and platforms for safe operation, maintenance, replacement, and repair of all equipment.
3. Maintainability designs shall minimize disruption of building functions. Every effort will be made to design, layout and install equipment in locations, which will tend to encourage routine preventive maintenance by providing easy access for maintenance personnel.

4. Manual isolation valves will be provided to enable servicing, expansion of, renovation or construction of any part of the existing facility without unscheduled interruption of services in adjacent areas.
5. Locate all shutoff and control valves for easy access and operation. Where valves must necessarily be located in enclosed spaces, they shall be provided with access panels of sufficient size for operation.

D. Materials
1. All materials/equipment shall bear the Underwriter's Laboratories (UL) label or be approved by Factory Mutual (FM) where UL labels or FM approval is available for the type of products specified or other Nationally Recognized Testing Laboratory (NRTL).
2. Unacceptable materials include:
   a. Acrylonitrile butadiene styrene (ABS) plastic pipe.
   b. Material or components containing asbestos, polychlorinated biphenyl (PCB), CFCs, lead, and carcinogens.
   c. Space shall be free from hazardous materials according to applicable federal, state, and local environmental regulations.
   d. Zinc chromate paint
   e. Class I Refrigerants
3. Relief valves
   a. Shall be ASME certified, where available.
   b. Pressure Relief Valves will be tested by Company before placing into service. Manufacturer's Pressure test for the subject relief valve shall be submitted to the Company for approval.
   c. Pressure Relief Valves will be tagged and recorded by Company for periodic testing. Periodic inspections will be performed by the Authority Having Jurisdiction.

E. Construction
1. Structural welding and acceptance criteria shall be to the applicable building and design code. Welders and weld procedures shall be qualified to the referenced American Welding Society (AWS) Structural Welding Code (AWS D1 series).
2. Welding activities associated with boilers, pressure vessel, power piping, and process piping and acceptance criteria shall be applicable to the ASME Boiler and Pressure Vessel Code (Section I, Section VIII or B31.1 and B31.3).
3. Welders and weld procedures shall be qualified to ASME Boiler and Pressure Vessel Code Section IX.
4. Examinations and testing shall be in accordance with the applicable codes. Examination and test reports shall be submitted to the Company.
5. Equipment shall be mounted on housekeeping pads.
6. All pipe supports shall be in accordance with MSS SP-58 standard.
7. Label all pipes in accordance with ANSI A13.1.
8. Relief valves shall be easily removed from the piping systems by means of flanges, threaded couplings, or other method.
9. Packaged system shall be installed on site by manufacturer or manufacturer's representative. Contractor to coordinate locations of plumbing and electrical utility connections and makes provisions for final connections.

F. Start-up
1. Packaged systems shall be commissioned with the manufacturer's representative onsite.
2. Site training shall be provided per Section 01 79 00.

3.2 PIPING SYSTEMS

A. Water.
1. Protect and conserve water
a. Indoor water use
1) Minimize the use and waste of indoor potable water, and in accordance with statute, implement water conservation technologies to the maximum extent that the technologies are life cycle cost-effective. Purchase water conserving products and ensure optimized water operations to the maximum extent possible.
b. Water metering
1) Install building level water meters in order to track and continuously optimize indoor potable water use, including detection of leaks.
c. Outdoor water use
1) Utilize current best practices and management strategies for water efficient landscaping, and employ, to the maximum extent practicable, water efficient irrigation strategies to track and reduce outdoor potable water consumption. Use non-irrigated, drought-tolerant native landscaping where practicable.
d. Alternative water
1) Maximize the use of alternative sources of water to the extent practicable and where permitted under local laws and regulations.
2. Building Water Supply
a. Design
1) Building water supply system: potable water pipe including the necessary connecting pipes, fittings, control valves and all appurtenances in the structure downstream of the building isolation valve.
2) Building water supply pressure shall not exceed 80 psi, IPC 604.8.
3) Backflow Prevention.
a) Backflow preventers shall be approved by the Foundation for Cross-Connection Control and Hydraulic Research and shall be warrantied for one year after accepted by the Company.
b) Backflow preventer centerline shall be no higher than five feet above floor/ground, unless permanent access for testing and servicing is provided.
c) Provide RPPBP or double check at potable water supply to automatic fire sprinkler and standpipe systems.
d) Provide RPPBP at branch lines supplying process or other water systems.
e) Provide (2) 100% redundant RPPBP on building water supply as the piping enters the building.
f) Provide (2) 100% redundant RPPBP to the building process water system.
4) Potable water heating shall meet the requirements of ASHRAE 90.1-2010.

5) Provide ASME code stamped tanks for hot water generation. Provide ASME approved relief devices.
6) The potable hot systems shall provide 120 °F hot water for all locations where fixtures for hand washing and showering occur, and 140 F hot water for general purpose use. Handicap accessible showers shall be limited to a maximum of 110 °F maximum. A recirculating hot water maintenance system shall be specified if required by the International Building Code.
7) Water softeners shall be specified where hard water will adversely affect equipment operation, maintenance and useful life. Softeners shall be provided with platforms for salt addition.
8) Valves shall be placed to isolate individual fixtures within one room or a battery of fixtures within one room.
9) System shall be designed to provide a minimum of 45 psi at the furthest outlet.
10) Provide an industrial water meter on both the domestic and process water systems which has a local display and electronic output to the Energy Management and Control System. Water meters shall be located inside the facilities wherever possible.
11) Water piping shall be sized based on the number of water fixture units connected, and the minimum flow pressure required at each fixture or piece of equipment. Pipe velocities shall be maintained between four and eight feet per second and shall not exceed eight feet per second.

b. Materials
1) Site Standards
a) Reduced pressure principle backflow preventers, RPPBP, Watts Regulator Company.
b) Water Meter: Flexim Fluxus F721 ultrasonic flow meter with Modbus TCP communications.

3. Fire Protection
a. The fire water service shall connect to the water main service and shall have a dedicated riser supply main entering the building.
b. The riser supply main shall be provided with a supervised post indicator gate valve (PIV).
c. Backflow Prevention.
1) Backflow preventers shall be approved by the Foundation for Cross-Connection Control and Hydraulic Research and shall be warranted for one year after accepted by the Company.
2) Provide RPPBP or double check at potable water supply to automatic fire sprinkler and standpipe systems.
d. Fire protection within the facility is covered in Section 01 86 13, Fire Protection.

4. Eye Wash and Safety Shower
a. Emergency showers and eyewash stations shall meet ISEA Z358.1.
b. Emergency showers and eyewash stations shall be provided with water from the building water supply system.
c. Water supplied to the emergency shower and eyewash stations shall be maintained between 72 degrees F and 90 degrees F, unless otherwise specified.
d. Valves capable of isolating the emergency showers and eyewash stations shall be tagged “Emergency shower and eyewash station isolation valve – DO NOT

OPERATE without approval of the Facility Engineer". Tags shall be permanently attached to the valve without interfering with the valve operation.

e. Heavy gauge nylon wire tie or similar material shall be installed to prevent inadvertent operation of the isolation valves.

f. Combined emergency shower and eyewash station or standalone emergency shower water shall drain to the floor with no floor drain, unless otherwise indicated.

g. Standalone eyewashes may be located at sinks with sanitary sewer or process drain connections.

h. Drains should not face the walls to facilitate testing.

i. Walls behind safety showers should be protected from water spray during use and testing.

j. Materials
   1) Site Standards
      a) Eyewashes and safety showers: Acorn, Bradley, Speakman, or company approved equal.
      b) Eyewashes: Bradley Emergency Eyewash Swing Activated S19-270 or company approved equal. [note this is a swing type for lab use]

5. Process Water.
   a. Process water shall be provided locally from the potable water system through an approved RPPBP.
   b. Water make-up to the mechanical equipment is supplied through the process water system.
   c. Hose bibs shall be provided in the mechanical room, at roof-mounted air handling units, on the perimeter of the building at intervals not exceeding 80 feet, minimum one per side, and other locations as determined during design. Exterior hose bibs shall be freeze proof.

6. Chilled Water Systems.
   a. Code/Design
      1) Chilled water: Chemically treated water re-circulated through mechanical cooling equipment.
      2) Chilled water and condenser water quality for the facility shall be considered commercial grade.
      3) Include strainers at all chilled water coils that will filter 100-micron particles.
      4) Dust particles, suspended or partially dissolved solids, etc. shall not be filtered and shall remain in the system.
      5) Pipe hangers and supports shall not penetrate the insulation on chilled water lines.
      6) Once through cooling systems are not allowed.
      7) See Section 01 86 19, HVAC for additional requirements.
      8) Chilled water shall be the cooling medium for satisfying all building and process cooling requirements.
   b. Materials
      1) Site Standards:
         a) Corrosion inhibitor and biological system per Utility Division contract.
         b) Meter: Flexim Fluxus F721 S Thermal Energy Meter, FLUXUS Type F721TE

c. Construction
   1) Chilled water systems and tower/condenser water systems be cleaned prior to start-up per Section .
7. Process Cooling Water.
   a. Code/Design
      1) Provide process closed loop cooling water system (s). The process cooling system(s) shall be designed to provide cooling to all laboratories.
      2) Process cooling water will be cooled by the building/plant chilled water system.
   b. Materials
      1) Site Standards:
         a) Corrosion inhibitor and biological system per Utility Division contract.

B. Wastewater.
1. Protect and conserve water
   a. Meet statutory requirements for new construction, modernizations, and renovations, and employ strategies that reduce stormwater runoff and discharges of polluted water offsite to protect the natural hydrology and watershed health. Where feasible, use low impact development (LID) strategies to maintain or restore the natural. Pre-developed ability of a site to manage rainfall.
2. General.
   a. Wastewater drainage systems: floor drains, sanitary sewer, storm water management system, chemical drains and laboratory waste.
   b. Storm Drainage System: All of the piping within a building that conveys rainwater, HVAC condensate, dechlorinated cooling water or similar liquid wastes to the ORNL Storm Sewer System or other point of disposal to the environment.
   c. ORNL Storm Sewer System: The common storm sewer conveying rainwater, surface water, subsurface water and similar liquid wastes to the ORNL outfalls.
3. Design wastewater collection systems for gravity flow unless such systems are not economically feasible.
4. Sustainability. Wastewater shall be evaluated for recovery and reuse where possible.
5. Storm Drainage.
   a. See Section 01 89 19, Site Plumbing Utilities, for ORNL Storm Sewer System criteria.
   b. The storm drainage system shall not be used for discharging of laboratory waste or sanitary drainage.
   c. The storm drainage system shall not be used for chlorinated water or water above 140ºF without pretreatment. Upset flows can contain chlorine or be hot for short durations (quantities) or long durations when corrective actions can be initiated.
6. Floor Drains.
   a. Do not provide floor drains for safety showers unless routed to laboratory waste tank.
   b. Where there is the possibility of the loss of the seal in floor/funnel drain traps, provide a trap primer valve and floor/funnel drain with a trap primer valve discharge connection.
   c. Do not route floor drains to the storm sewer.
   d. Floor drains shall go to sanitary sewer unless located in rooms where fuels, chemicals or other similar hazardous materials exist.

e. Where fuels, chemicals, and other hazardous materials may be found route floor drains to the laboratory waste tank, provide no floor drains or provide raised drains to sanitary sewer.
f. Minimize the number of floor drains in mechanical rooms and central energy plants to prevent possible contamination (oil, etc.) transfer to the sanitary sewer system.
g. Floor drains located in restrooms shall be placed out of the walking areas.

7. Handling of Water and Wastewater at ORNL, unless otherwise noted:
   a. Types of wastewater piped to the Storm Drainage System:
      1) Roof drains.
      2) AHU condensate. See Wastewater Sustainability in this section.
      3) Humidifier water blow-down or recover water and send to cooling tower makeup.

C. Vacuum.
1. Vacuum systems are defined as starting from the vacuum pump inlet to point of use. The following are the various ORNL vacuum systems and their design parameters:
   a. Laboratory vacuum: For any deep vacuum requirements provide local vacuum equipment.
   b. House vacuum system: 125° F and 10 torr.
2. Provide a skid mounted duplex vacuum pump system, utilizing dry technology, complete with all appurtenances, including an ASME Code stamped, National Board registered receiver labeled for full vacuum service.
3. The house vacuum system shall be connected to the lab bench outlets, with a total system drop of 4"x 10-6 mm Hg.

D. Compressed Air.
1. Code/Design
   a. Provide central compressed air where available.
   b. The system shall be designed for loads indicated in the room data sheets.
   c. Each hose connection and outlet shall have shut off valve, filter, gauge and pressure regulator.
   d. Central compressed plant air is compressed air, not oil free, available at 100 psig pressure and dried to a dew point of -50°F to -70°F.
   e. Instrument air is defined as compressed air that is oil free and dried to a specified dew point.
   f. Maximum pressure at air hose outlets is 15 psi.
   g. Provide laboratory compressed air that is oil free and dried to -40F dew point.
   h. The system shall supply 100 psi to the risers and specific equipment with pressure reducing stations on each floor for distribution of 15 psi to the lab benches. Sizing of the system will be based on 1 CFM per outlet.
   i. Provide ASME stamped air or by a dedicated 100% redundant oil-free compressors. A single accessible compressor(s), receiver vessel located in the first-floor mechanical room.(s), dryer(s) and filter(s).
   j. Provide flow instrumentation with electronic output for connection to Energy Management and Control System.
2. Material
   a. Piping: ASTM A106;
   b. Site Standard:

1) Flow Meter: Sierra Instruments Quadratherm 640i-VTP thermal mass flow meter with 316 stainless steel meter body, Modbus RTU communications and 24 VDC electrical power input, remote display if meter is installed more than 6’ above finished floor. Meter shall include bypasses with isolation valves.

E. Gases
1. Compressed gas piping systems are from the outlet of the generating equipment, bottle station manifold, or storage facility to point of use.
2. Provide gas cylinder storage and unloading space at the loading dock.
3. Materials
a. Sierra Instruments 780i-VTP (velocity, temperature, pressure) with 316 stainless steel meter body, remote display if meter is installed more than 6’ above finished floor, 120 VAC input power and Modbus RTU output for hardwired connection to the Energy Management and Control System or approved equal.
b. Fox Thermal Gas Mass Flow Meter, FT1 or FT2A, with Modbus output or approved equal

F. Refrigerants.
1. Piping systems for refrigerants is covered under Section 01 86 19, HVAC.

END OF SECTION 01 86 16

SECTION 01 86 19 - HEATING, VENTILATING AND AIR-CONDITIONING (HVAC)

PART 1 - PROJECT REQUIREMENTS

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. The HVAC performance requirements for this project are contained in ORNL AML Expansion Internal Estimating Document and room data sheets. There are special vibration, acoustic, EMI, air cleanliness and temperature control requirements that must be achieved as a result of the design, installation and operation of the facility addition and related systems.

B. Provide new HVAC related systems and equipment as needed to support the precise and unique environmental control requirements associated with successful operation of research instrument and equipment planned for this facility addition:
1. The mechanical air handling system fir the instrument room(s) shall be controllable to a temperature of 68 °F/hour with a relative humidity in the instrument and control rooms of 30-55%.
    a. The system shall maintain air motion to 5 cm/second or less.
    b. Noise created by the mechanical equipment shall be the following:
        1) Attenuated to a noise criterion (NC) of 20 or less in the instrument rooms
        2) Limited to 50dB overall
        3) Limited to 45dB in any 1/3 octave band from 100Hz to 10kHz
        4) Limited to 45dB for the portion of the spectrum between 5Hz and 100Hz.
    c. Air conditioning shall be a proportional system, in which an air-cooling unit is running continuously, as the air is reheated as needed to maintain the required temperature.
    d. This level of performance has not been achievable with an on/off regulation of HVAC air supply.
2. Air filtration is to be included in the Heating, Ventilating, and Air-Conditioning (HVAC) with High Efficiency Particulate Air filtration to maintain a dust free environment.
3. Central vacuum service shall be provided to assist in the operation and maintenance of the instruments. Exterior air discharge is required.

C. Calculations.
1. All HVAC calculations, equipment selections, air distribution and relevant design shall be in accordance with applicable procedures and guidelines from ASHRAE handbooks and referenced industry standards.
2. Required design analysis/calculations include but are not limited to the following heating, cooling and ventilating loads; make-up and exhaust air requirements; equipment sizing; ductwork sizing and static pressure losses (as appropriate); sound levels; computer

generated peak zone heating and cooling loads; computer generated zone and system hour-by-hour heating and cooling load analysis; utility consumption for a dynamic building energy consumption analysis; calculations and documentation of life cycle cost analysis; calculations and documentation supporting compliance with ASHRAE Standard 90.1-2013.

3. Exhaust stack design and re-entrainment avoidance calculations are a required design deliverable.

D. Reliability.

1. The HVAC design of this facility shall maximize operational reliability without necessarily providing 100% equipment redundancy.
2. Design, select and specify HVAC equipment, systems and controls to enhance facility environmental control stability.

E. Flexibility.

1. The size and selection of HVAC equipment shall meet the heating, ventilation and cooling loads of the facility spaces, occupants and process equipment loads.
2. The total heating and cooling capacity of installed equipment shall exceed the base load requirements by ten percent to provide additional capacity for the future.

F. Special TAB and commissioning.

1. The Seller shall furnish TAB subcontractor services.

2. Owner shall furnish project commissioning agent.

3. The Seller shall support project commissioning activities with participation from mechanical, electrical, controls, TAB and other subcontractors as required.

G. DDC and BAS requirements.

1. Equipment controllers shall be electronic, direct digital controls-based products as manufactured and/or furnished by Johnson Controls, Inc. (JCI).

2. All HVAC equipment and controls shall be Building Automation and Control Networking Protocol (BACnet) compatible and shall be connected to the Oak Ridge National Laboratory (ORNL) site, JCI Metasys N2 web-based, BAS.

PART 2 - CODES AND STANDARDS

2.1 DESIGN STANDARDS

A. Work Smart Standards referenced in Section 01 41 00 apply to this Section.

B. Additional Standards/Guides.

1. Air-Conditioning, Heating and Refrigeration Institute (AHRI)

a. AHRI 210/240, Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
b. AHRI 310/380, Packaged Terminal Air-Conditioners and Heat Pumps.
c. AHRI 340/360, Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.
d. AHRI 350, Sound Performance Rating of Non-ducted Indoor Air-Condtioning and Heat Pump Equipment.
e. AHRI 365, Commercial and Industrial Unitary Air-Conditioning Condensing Units.
f. AHRI 370, Sound Performance Rating of Large Air-cooled Outdoor Refrigeration and Air-Condtioning Equipment.
g. AHRI 390, Performance Rating of Single Package Vertical Air-Conditioners and Heat Pumps.
h. AHRI 410, Forced-Circulation Air-Cooling and Air-Heating Coils.
i. AHRI 430, Central-Station Air-Handling Units.
j. AHRI 440, Performance Rating of Fan-coil Units.
k. AHRI 530, Rating of Sound and Vibration for Refrigerant Compressors.
l. AHRI 540, Rating of Positive Displacement Refrigerant Compressors and Compressor Units.
m. AHRI 545, Rating of Modulating Positive Displacement Refrigerant Compressors.
n. AHRI 640, Performance Rating of Commercial and Industrial Humidifiers.
o. AHRI 700, Specifications for Refrigerants.
p. AHRI 850, Performance Rating of Commercial and Industrial Air Filter Equipment.
q. AHRI 880, Performance Rating of Air Terminals.
r. AHRI 885, Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.
s. AHRI 920, Performance Rating of DX-Dedicated Outdoor Air System Units
t. AHRI 1140, Sound Quality Evaluation Procedures for Air-Conditioning and Refrigeration Equipment.
u. AHRI 1210, Performance Rating of Variable Frequency Drives
v. AHRI 1230, Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment.

2. Air Movement Contractors Association (AMCA)
   a. Publication 201, Fans and Systems.
   b. Standard 210, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
   c. Standard 500-D, Laboratory Methods of Testing Dampers for Rating.
   d. Standard 500-L, Laboratory Methods of Testing Louvers for Rating.
3. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)
   a. Standard 15, Safety Standard for Refrigeration Systems.
   b. Standard 16, Method of Testing For Rating Room Air Conditioners, Packaged Terminal Air Conditioners and Packaged Terminal Heat Pumps for Cooling and Heating Capacity.
   c. Standard 33, Methods of Testing Forced-Circulation Air-Cooling and Air-Heating Coils.
   d. Standard 34, Designation and Safety Classification of Refrigerants
   e. Standard 37, Methods of Testing for Rating Electrically Driven Unitary Air-Conditioning and Heat Pump Equipment.

f. Standard 40, Methods of Testing for Rating Heat Operated Unitary Air-Conditioning and Heat-Pump Equipment.
g. Standard 41.1, Standard Methods for Temperature Measurement.
h. Standard 41.2, Standard Methods for Air Velocity and Airflow Measurement.
i. Standard 41.3, Standard Methods for Pressure Measurement.
j. Standard 41.6, Standard Methods for Humidity Measurement.
k. Standard 51, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
l. Standard 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
m. Standard 55, Thermal Environmental Conditions for Human Occupancy.
n. Standard 62.1, Ventilation and Acceptable Indoor Air Quality.
o. Standard 70, Method of Testing for Rating the Performance of Air Outlets and Air Inlets.
p. Standard 79, Method of Testing for Fan-Coil Units.
q. Standard 84, Method of Testing Air-to-Air Heat/Energy Exchangers.
r. Standard 90.1, 2010 Edition, Energy Efficient Design of New Buildings, Except Low-Rise Residential Buildings,
s. Standard 103, Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers.
t. Standard 105, Standard Methods of Measuring and Expressing Building Energy Performance.
u. Standard 110, Method of Testing Performance of Laboratory Fume Hoods.
v. Standard 111, Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation and Air-Conditioning Systems.
w. Standard 113, Method of Testing for Room Air Diffusion.
x. Standard 116, Methods of Testing for Rating Seasonal Efficiency of Unitary Air-Conditioners and Heat Pumps.
y. Standard 129, Measuring Air-Change Effectiveness.
z. Standard 135, BACnet – A Data Communication Protocol for Building Automation and Control Networks.
aa. Standard 160, Criteria for Moisture-Control Design Analysis in Buildings.
bb. Standard 169, Climatic Data for Building Design Standards.
cc. Standard 183, Peak Cooling and Heating Load Calculations in Buildings Except Low-Rise Residential Buildings.
dd. Standard 193, Method of Test for Determining the Airtightness of HVAC Equipment.
ee. Standard 202, Commissioning Process for Buildings and Systems.
ff. Standard 203, Method of Test for Determining Heat Gain of Office Equipment Used in Buildings.
gg. Standard 215, Method of Test to Determine Leakage of Operating HVAC Air-Distribution Systems.
hh. Standard 221, Test Method to Field-Measure and Score the Cooling and Heating Performance of an Installed Unitary HVAC System.
ii. Applications Handbook.
jj. Fundamentals Handbook.
kk. Refrigeration Handbook.
ll. Systems and Equipment Handbook.
mm. Manual, Design of Smoke Control Systems for Buildings.

nn. Cooling and Heating Load Calculation Manual.
4. American Society of Mechanical Engineers (ASME)
   a. AG-1, Code on Nuclear Air and Gas Treatment.
5. National Fire Protection Association (NFPA)
   a. NFPA 45, Standard on Fire Protection for Laboratories Using Chemicals
   b. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
   c. NFPA 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
   d. NFPA 91, Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids.
6. NSF International (NSF) (http://www.nsf.org).
   a. NSF 49, Class II (Laminar Flow) Biohazard Cabinetry.
7. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
   a. HVAC Duct Construction Standards Metal and Flexible.
   b. Rectangular Industrial Duct Construction Standards.
   c. Round Industrial Duct Construction Standards.
8. Mold Litigation Task Force of the Associated General Contractors of America, Inc.
   a. Managing the Risk of Mold in the Construction of Buildings.

C. Engineering Standards
   1. Laboratory Fume Hoods
   2. Bag-In/Bag-Out High Efficiency Particulate Air Filter System
   3. The above standards are accessible in “Project Wise”.

PART 3 - TECHNICAL REQUIREMENTS

3.1 HVAC DESIGN REQUIREMENTS

A. General.

Designer Note: Quality control issues have been experienced at Y-12 with industrial sized Twin City fans and Westinghouse motors.

   1. Equipment specifications shall reflect standard, commercially available equipment that allows a reasonable range of competitive bidding. At least three reputable companies capable of manufacturing the specified equipment shall be identified as potentially acceptable manufacturers for competitive bidding. In addition, manufacturers of major equipment (e.g., boilers and chillers) shall have obtained a satisfactory commercial, industrial and ORNL Site record of past equipment experiences before their addition in the specifications as acceptable manufacturers. Manufacturers identified by UT-B/ORNL/FDD personnel as having a poor performance or reliability record at the ORNL site shall not be included as acceptable manufactures.
   2. The specification of electric heating equipment in HVAC systems is prohibited unless justified through a life-cycle cost analysis.
   3. HVAC systems and equipment shall meet the minimum energy efficiency requirements of 10CFR433 and the 2013 edition of ASHRAE 90.1, as applicable.

4. All air conditioning and refrigeration equipment shall comply with applicable AHRI standards as a minimum requirement.
5. HVAC equipment shall be sized to satisfy space and/or process heating and cooling load requirements in accordance with the general equipment design and selection criteria contained in the ASHRAE Fundamentals Handbook, ASHRAE Systems and Equipment Handbook, ASHRAE Applications Handbook, and ASHRAE Refrigeration Handbook.
6. Calculations and equipment selection shall be made according to the procedures given in ASHRAE Cooling and Heating Load Calculation Manual and appropriate chapters of the ASHRAE Fundamentals Handbook.
7. Infiltration for heating and cooling design loads shall be calculated according to the methods provided by the ASHRAE Fundamentals Handbook.
8. Seismic design and anchorage of mechanical equipment and system components shall be in accordance with Section 01 82 00, Structural.
9. The design and construction of a facility shall follow practices outlined in “Managing the Risks of Mold in the Construction of Buildings”.
10. Entry and vestibule areas shall be heated and cooled by the building’s central air-conditioning system(s).
11. Use of wall mounted mini-split systems in conference rooms, offices and finished areas other than communications/equipment rooms is prohibited.
12. Use of suspended ceiling mounted mini-split systems requires company approval.
13. Use of existing equipment in new construction and major renovations is prohibited.

B. Design Conditions.
   1. General.
      a. Environmental design temperatures and relative humidity for special space uses other than those listed here shall be designated in the project criteria.
      b. The design professional shall verify that the recommended design values are within the criteria bounds of ASHRAE Standard 55 and that the values are in accordance with criteria guidelines in Section 01 11 00, Summary of Work.
   2. Inside Design Temperature and Relative Humidity.
      a. When space cooling is required, the inside design temperature to maintain personnel comfort shall be 76 +/- 2°F dry bulb (db) unless otherwise indicated by project criteria. The design relative humidity shall be 55 +/- 5%. Cooling systems shall be designed to maintain space relative humidity conditions through the normal cooling process and should not have controls to limit the maximum relative humidity unless project specific criteria dictate.
      b. The inside wintertime design temperature for personnel comfort shall be 72°F db unless otherwise directed by the project criteria.
      c. Winter humidification for personnel comfort and health shall not be provided unless recordings or engineering computations indicate inside relative humidity levels less than 30%. Where such conditions exist, a design relative humidity of 30% shall be used in establishing minimum humidification equipment requirements.
      d. Ventilation design for general heat relief shall limit the temperature rise of spaces to 10°F maximum above the outside design dry bulb temperature.
   3. Outside Design Temperatures.
      a. For space personal comfort conditions, the design professional shall size the HVAC system equipment using outside design temperatures as indicated in ASHRAE Fundamentals Handbook for the Oak Ridge/Knoxville TN area. The

winter design temperature shall be the ASHRAE 99% value, and the summer design shall be the 1% value.

b. Process designs, i.e., non comfort conditioning applications, shall use the 99.6% and 0.4% ASHRAE winter and summer temperatures respectively.

c. Cooling tower and evaporative condensers sizing shall use the 0.4% mean coincident wet bulb temperatures for design purposes.

C. Exhaust Stacks

1. ***Design requirements for stacks***

a. Exhaust stacks shall be designed to meet the needs of the project/mission and the requirements of all applicable codes and standards (see list below).

b. Additionally, project-specific requirements shall be identified and addressed in the final design solution.

c. A primary performance requirement of the exhaust stack is to ensure re-entrainment is prevented.

d. The designers shall include a documented evaluation that the design has addressed the issue of re-entrainment.

e. The evaluation must include exhaust stack calculations and/or modeling as needed [dispersion (AERMOD or equivalent) or computational fluid dynamics] to support the design solution conclusion that re-entrainment is not a concern.

1) The geometric method may be used for estimating stack height to prevent reentry of exhaust gas into the emitting building if no large structures or terrain are nearby to disturb the approaching wind.

2) Calculation methods to determine the outdoor dilution of exhaust emitted from a rooftop stack because of atmospheric dispersion shall be used when the geometric method is inappropriate and/or ineffective at determining the appropriate stack height to prevent re-entrainment of exhaust air into building intakes.

3) Dispersion models ranging from simple to very complex are described in the “Building Air Intake and Exhaust Design” chapter of the ASHRAE Applications Handbook.

f. The overall design must ensure sufficient make up air is provided/available to prevent adverse negative pressure conditions inside the facility when the stack is operational.

g. Coordination with NRPD and EPSD is necessary when stack monitoring and/or sampling is required.

2. ***Approval of stack installations and/or modifications***

a. The approval/commissioning activities for the stack shall verify and validate that the stack is performing as designed (including satisfying those key performance parameters required to prevent re-entrainment).

3. ***Transition to Operations for new and/or modified stacks***

a. Design and/or project engineers shall provide the respective facility engineer with information containing the key stack performance parameters (e.g. required stack exhaust velocity to prevent re-entrainment).

4. ***Applicable codes and standards for stack designs***

a. Project and design engineers shall tailor the appliable requirements to meet the project / mission needs while ensuring compliance. Applicable codes and standards for exhaust stack design at ORNL include, but may not be limited to, the following:

1) 2012 International Mechanical Code
2) The International Mechanical Code (UT-B project/design engineer - insert the edition currently adopted in the UT-B Work Smart Standards Set 9 and SBMS Engineering Design subject area)
3) 2019 ASHRAE Applications Handbook, chapter 46, “Building Air Intake and Exhaust Design” (as referenced in ANSI Z9.5-2012)
4) 2017 ASHRAE Fundamentals Handbook, Chapter 24, “Airflow Around Buildings” (as referenced in DOE O 420.1C Change 2 and International Mechanical Code WSS Set 9 edition)
5) ASHRAE Standard 110-2016, Method of Testing Performance of Laboratory Fume Hoods (as referenced in Engineering Standard ES-5-2 Rev A)
6) ASHRAE Laboratory Design Guide 2nd Edition
7) ANSI Z9.2-2012, Fundamentals Governing the Design and Operation of Local Ventilation Systems (10 CFR 851.23(a)(3): 29 CFR 1910, Subpart G, 1910.94 requires ANSI Z9.2-1960, DOE O 420.1C Change 2 references ANSI Z9.2-2012)
8) ANSI Z9.5-2012, Laboratory Exhaust Ventilation (as referenced in SBMS Ventilation, Local Exhaust subject area and ES-5-2 Rev A Engineering Standard)
9) NFPA 45, Standard on Fire Protection for Laboratories Using Chemicals, current edition, (as referenced in WSS WSH Internal #13, WSH Program Description, and SBMS Ventilation, Local Exhaust subject area)
10) ACGIH Industrial Ventilation: A Manual of Recommended Practice for Design, current edition, (as referenced in DOE O 420.1C Change 2, SBMS Ventilation, Local Exhaust subject area, and Engineering Standard ES-5-2 Rev A)
11) 40 CFR Part 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities" (as referenced is WSS Set 1)
12) ANSI/HPS N13.1-1999. Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities. American National Standards Institute and the Health Physics Society, McLean, VA (reaffirmed in 2011 as ANSI/HPS N13.1-2011)
13) Another reference that contains information on stack design is the DOE Nuclear Air Cleaning Handbook which is technical standard DOE-HDBK-1169-2003.

D. Mechanical Insulation.

1. General Insulation Requirements.

a. All supply and return air ductwork, casings, and air-handling equipment for the air conditioning systems that are not within the conditioned area shall be insulated in accordance with the Company's technical specifications. Minimum thickness for fiberglass duct wrap shall be 1 ½” and other insulating material shall be sized to provide an equivalent insulating value.

b. The typical AHU housing preference is double wall galvanized steel (G90) construction with 1-1/2 pound per cubic feet density rigid glass fiber insulation tightly bonded to the panels. Exterior surface finish shall be in accordance with project specific criteria.

c. If double wall AHU housing construction is not available, then the insulation inside the air handler shall have a neoprene coating or tightly bonded aluminum on the side exposed to the air stream.
d. Insulation shall be provided for equipment, ductwork, flue pipe and breeching to minimize energy loss, to prevent condensation, and to provide safe surface temperatures.
e. All insulation material, media used to apply insulation, and jacketing material shall have a maximum flame spread of not more than 25 fuel-contributed and smoke-developed ratings of not over 50 when tested using Underwriters' Laboratories, Inc. (UL) 723, Test Methods.
f. Insulation material, thickness, and jacketing shall be designed to provide an exterior skin surface temperature greater than the minimum anticipated ambient dew point for condensation prevention.
g. Site Standards
   1) Use of fiberglass insulation must be reviewed by the Company
   2) Asbestos or asbestos-containing materials shall not be used.

2. Refrigerant Piping Insulation.
   a. Refrigerant suction lines shall be insulated with closed-cell type rubber tubing insulation, as manufactured by Armaflex or Rubatex Corporation, or its equivalent. Insulation and adhesives used must be the self-extinguishing, fire retardant type.
   b. Minimum insulation thickness shall be 1” and method of application shall be as recommended by the insulation manufacturer.
3. Plant and Equipment Insulation.
   a. All hot surfaces within 7 ft of the plant floor or any catwalk shall be insulated to prevent surface temperatures above 130°F where contact would be inadvertent and 120°F where contact is likely or necessary for equipment operation.

E. Fire Protection Requirements.
1. General.
   a. Fire protection methods must be reviewed and accepted by the Authority Having Jurisdiction (AHJ). Some Section 01 86 13, Fire Protection, requirements (fire suppression, fire rated construction, physical separation, etc.) may impact the HVAC system.
   b. See Section 01 86 16, Fire Protection, for comprehensive project specific requirements.
2. Fire Rated Construction.
   a. Ductwork shall also be designed to comply with NFPA 90A, including specification and installation of smoke and fire dampers at fire wall penetrations and smoke pressurization/containment dampers as required for smoke pressurization/evacuation systems.
   b. All mechanical and electrical penetrations made into fire rated plenum enclosures shall be fire stopped by listed materials meeting the requirements of ASTM E-814 with a fire rating not less than the rated enclosure.
   c. Fire Dampers.
      1) Fire dampers in ductwork shall not be utilized when penetrating the fire rated construction where the ductwork is an integral part of the air filter system equipment that is required to continuously function as part of the confinement system or any system that meets the requirements of NFPA 91.

2) Duct material penetrating fire rated construction without fire dampers shall be made part of that fire rated construction by either wrapping or spraying or enclosing the duct with an approved material.
3) Ductwork penetration shall be made part of that fire rated construction by separating the duct material from other parts of the building with equivalent required fire rated construction.
4) Ductwork penetration fire rated construction shall be qualified by an engineering analysis in accordance with DOE-STD-1066-99, Appendix D.

3.2 TESTING, ADJUSTING AND BALANCING (TAB)

A. General.
1. Test and measuring locations shall be noted on construction drawings. The use of duct mounted airflow monitoring stations shall be considered where limited duct space or configuration restrict the use of pitot tube traverse procedures or where especially sensitive measuring requirements are dictated by the project criteria. All automatic/electronic means of measurement shall be capable of directing communicating with the ORNL campus standard Johnson Controls "Metasys" building management system.
2. Detailed test procedures for the preoperational checkout of the HVAC systems shall be performed in accordance with Section 01 91 33, Commissioning.
3. A listing of the inspections, tests and submittals required by the project specifications shall be prepared and detailed on the Commissioning Agent's forms and attached to Commissioning Report.
4. Operational startup, testing, and balancing shall not begin until preoperational checkout activities are completed with signatures.

B. Testing and Balancing Devices.
1. HVAC air and water distribution systems shall be provided with permanently installed calibrated testing and balancing devices and all water systems shall have permanently installed flow and temperature measuring equipment. Accessibility shall be provided to accurately measure and adjust water or air flows, pressures, or temperatures as required. Al permanently installed flow and temperature measurement equipment shall be capable of directing communicating with the ORNL campus standard Johnson Controls "Metasys" building management system.
2. The design professional shall provide as a minimum the balancing devices in Tables 01 86 19-A and 01 86 19-B. Test devices shall be located and installed according to the AABC National Standards for Total System Balance 2002.

Table 01 86 19-A
Required balancing devices for air distribution systems

System Components	Required System Devices
Diffusers, grilles	Round butterfly or square/rectangular opposed blade volume damper, either registers integral with device or in spin-in take offs

Branch ductwork runs	Rectangular/square or round (with more than one opposed blade damper and terminal device). Sealed test hole for pitot tube traverse
Fan discharge ductwork	Sealed test holes for pitot tube traverse. Sealed test hole for static pressure measurements
Fan suction ductwork	Sealed test hole for static pressure measurement
Cooling coil suction and discharge airstreams	Duct-mounted air stream thermometer
Heating coil suction and discharge air streams	Duct-mounted air stream thermometer
Mixed air plenum air stream	Duct-mounted air stream thermometer

Table 01 86 19-B
Required balancing devices for water and steam distribution systems

System Components	Required System Devices
Chiller evaporator water suction and discharge piping	Thermometer/test well and pressure gage and gage cock
Chiller condenser water suction and discharge piping	Same devices as required for chiller evaporator piping
Heating or cooling coil (AHU) suction and discharge piping	Thermometer/test well; pressure gage/pressure tap
Heating or cooling coil (AHU) discharge piping	Pre-settable calibrated balancing valve with integral pressure test ports
Discharge and Suction piping for reheat coils, fan coil units, unit heaters, ports and finned tube radiation convectors	Pre-settable calibrated balancing valve with integral test ports, temperature test, pressure tap
Three-way control valves for suction and discharge piping	Pressure tap
Boiler discharge piping	Flow measuring device (orifice or venturi type)

3.3 CENTRAL COOLING AND HEATING REQUIREMENTS

A. General.
1. The existing ORNL central steam and chilled water systems shall be the heating and cooling medium of choice for design of new or retrofitted HVAC systems. Exceptions include cost ineffective installations similar to the following scenarios:
a. If the central system equipment and/or pipe sizes are inadequate to serve the new HVAC systems.
b. If the distance from the new HVAC systems to the nearest source of central steam and chilled water supply is excessive and extension of the central systems could not be economically justified.

2. The design professional shall evaluate the cost effectiveness of connecting to the central steam plant’s condensate return system when heating air and/or water systems with steam.
3. Multiple facilities may be serviced with a new central plant where it is not cost effective to connect to the existing ORNL central chilled water plant (Bldg. 4509).

B. Plant equipment.
1. Water chillers.
   a. The selection of centrifugal, reciprocating, helical, rotary-screw, absorption, or steam powered chillers shall consider coefficients of performance at full load and part load conditions using the energy conservation methods as described in Section 01 81 13, Energy and Sustainability.
   b. Size, selection, and design shall be based on applicable ASHRAE handbooks and ASHRAE 90.1-2013. Refrigeration equipment shall comply with all applicable ARI Standards, unless otherwise noted. The use of multiple chillers for chilled water loads greater than 400 tons is preferred.
   c. Compression refrigeration machines shall be designed with the safety controls and relief devices. Chiller controls shall at a minimum include:
      1) High discharge refrigerant pressure cutout switch.
      2) Low evaporator refrigerant pressure or temperature cutout switch.
      3) High and low oil pressure switches.
      4) Chilled water flow interlock switch.
      5) Condenser water flow interlock switch (on water cooled equipment).
      6) Chilled water low temperature cutout switch.
   d. Refrigeration compressors shall be selected and designed for capacity modulation down to 20% without surge.
   e. Selection and specification of equipment shall not allow hot gas bypass control of compressors except when providing capacity modulation below 10% of rated load, if required.
   f. Absorption refrigeration machines shall at a minimum be provided with the following safety controls:
      1) Condenser water flow switch.
      2) Chilled water flow switch.
      3) Evaporation refrigerant level switch.
      4) Generator high temperature limit switch (gas-fired units).
      5) Generator shell bursting disc (high temperature water or steam).
      6) Concentration limit controls.
   g. Liquid coolers (evaporators) shall be designed to meet requirements of ASHRAE Standard 15 and ASME Boiler and Pressure Vessel Code, Sect. VIII.
   h. The chiller manufacturer’s recommendations regarding appropriate lubricants shall be followed; however, oils containing PCBs will not be permitted.

C. Building equipment.
1. Fans/motors.
   a. Fans shall be designed and specified to assure stable, non-pulsing aerodynamic operation in the range of operation over varying speeds. AHUs and fans in sizes over 1 hp shall use belt drives.
   b. Fans with motors of 10 hp or less shall be designed with adjustable motor pulley sheaves to assist in air balancing of systems. Fans with motors greater than 10 hp

shall use fixed (nonadjustable) drives that can be adjusted by substituting fixed motor pulley sheaves of different diameters.

c. Supply AHUs and return air fans in variable air volume systems shall be designed for control of capacity. Fans shall comply with AMCA Standard 201, ASHRAE Standard 51, and ASHRAE Equipment Handbook.

d. Fans/ductwork interface shall be per the requirements of AMCA Publication 201 and ACGIH Industrial Ventilation Manual. Fan system effect factors shall be determined in accordance with AMCA Publication 201 and added to the static pressure for sizing and selecting fans.

e. Spark resistant construction shall be used where required by NFPA.

f. Generally fan motors 1/2 hp and larger shall be three-phase, 460V, induction type motors. Totally enclosed fan cooled motors are required for unprotected outdoor locations. Generally, open drip proof motors shall be used indoors and in protected outdoor locations. Across the line starting shall be used for motors 100 hp and smaller. Generally, reduced voltage starting shall be used for motors larger than 100 hp. Motors shall be sized to overcome fan inertia at startup and to provide bhp requirements of the load plus drive losses. Motors shall be the high efficiency type. Insulation class and temperature rise shall be selected for the ambient temperature at which the motor is to operate at the specified service factor.

g. Centrifugal-type fans with backward inclined or airfoil non-overloading wheels are preferred.

h. Bearings shall have a minimum L-10 life of 80,000 hrs as defined by American National Standards Institute (ANSI)/Anti Friction Bearing Manufacturer's Association Standard II.

i. Bearings shall have fittings for lubrication and relief. Pipe extensions and fittings shall be provided to allow lubrication of equipment without removal of the safety guards.

j. Belt drives shall be designed in accordance with engineering data developed by the drive industry. Designs shall include overload service factors and operating conditions in determining the total percentage above fan motor nameplate horsepower; 140% is a minimum for any application.

   1) Safety guards shall be provided in accordance with SMACNA Standards and OSHA requirements to enclose the exposed sides of moving parts, including, but not limited to, couplings, sheaves, shafts, and belts.

   2) Tachometer openings with removable covers shall be provided for measuring driver and driven shaft speeds without removing the safety guard.

k. The entire project is considered to be a "special application" requiring especially-low vibration levels. Assemblies shall be dynamically balanced to a minimum of Grade 2.5 or better per ASA S2.19.

l. Vibration isolation bases shall be provided for rotating equipment. Isolators shall generally be limited to a transmissibility of 1% in all areas

m. All fan motors shall be equipped with shaft grounding rings to reduce bearing maintenance costs.

2. Air handling units.

a. The design of air handling equipment and air distribution systems shall optimize both initial cost and air handling system operating and maintenance costs.

b. The design professional shall provide air handling system equipment (fans, terminal units, AHUs, etc.) with vibration isolators and flexible ductwork connectors to minimize transmission of vibration and noise.

c. Systems shall satisfy the noise control levels recommended for various types of spaces and vibration criteria as listed in the ASHRAE handbooks or as specified in the project criteria. Sound attenuation devices shall be installed in the air handling systems if necessary to maintain specified noise levels.
d. Airflow diagrams and system P&ID's shall be developed and provided in the preliminary design phase for each air handling and air distribution system and shall include capacities and locations of fans, coils, filters, terminal devices, and other major air distribution system equipment, as well as airflows and system air pressures and space pressure differentials.
e. Airflow velocities shall be designed to minimize settling of entrained particles as outlined in the ACGIH Industrial Ventilation Manual.

3. Coils – general.
   a. Heating and cooling coil performance shall comply with and be certified to ARI 410.
   b. Cooling coils shall be designed with a maximum face velocity of 500 fpm. Coils shall be specified with drain feature.
   c. Air systems with significant percentages of outside air resulting in a mixed air temperature of 35° or less shall be designed with a preheat coil.
   d. Preheating coils shall be specified and designed to maintain discharge air temperature without use of integral face and bypass dampers.
   e. Coils shall be tested by the manufacturer at 300 psi.
4. Cooling coils.
   a. Chilled water, brine, and direct expansion cooling coils shall be certified and rated in accordance with the latest edition of ARI Standard 410. Aluminum fins and copper tubes shall be used. Tubes (1 in. O.D.) shall have a minimum wall thickness of 0.032 in.; 0.625-in. O.D. tubes shall have a minimum wall thickness of 0.024 in. The fin thickness shall be a minimum of 0.009. Coils shall be tested at 300 psig.
   b. Cooling coils for spray coil service shall have copper fins to resist corrosion.
   c. Water and brine coils shall be provided with accessible plug drains and air vents.
5. Heating coils.
   a. Hot water and steam coils shall be rated and certified in accordance with the latest edition of ARI Standard 410. Water heating coils shall have a maximum face velocity of 500 fpm. Steam coils shall have a maximum face velocity of 700 fpm.
   b. Hot water coil materials, tube wall, and fin thickness shall be as described above for chilled water coils.
   c. Steam coils shall have tube wall thickness of 0.049 in., and fin thickness shall be 0.009 in. Steam coils shall have cupro nickel tubes and headers. Where the coil will be subjected to air at a temperature less than 35°F, it shall be a steam distributing, double tube type with 1 in. O.D. outer tubes; the tubes shall be oriented in a vertical position when practical. For reheat service the coils may be of either the single tube or the steam distributing type unless the specific application requires an even temperature distribution across the face of the coil.
6. Electrical heating coils.
   a. Electrical heating coils shall have low mass, exposed wire heating elements, unless hazardous or corrosive atmospheres require enclosed, finned tube elements.
   b. Electrical heating coils shall be protected with automatic and manual reset type snap disc or bulb type safety devices in both the power and control circuits. A sail

switch or other airflow sensor shall be interlocked with the fan and a visual alarm. See Section 01 86 26, Electrical, for additional information on protective devices.

c. Heating coils operating on 120 and 240V power shall be controlled by single or multistage line voltage thermostats. Heating coils operated on 480V power shall be controlled by a temperature sensor coupled with a time proportioning switch, step controller, and electrical contactors, or SCR controller if precise control is required.

d. Controls, such as contactors, step and proportional controllers, time proportioning switches, disconnects, pressure electric switches, SCR controllers, and differential pressure switches, shall be installed in accessible, visible locations outside the duct heater enclosure.

e. Coils shall bear a UL label (preferred) or state that the have been manufactured in compliance with UL design criteria and production requirements and could bear the UL label if they were assembled with a UL tested and approved contactor and/or with a flow sensing device installed by the duct heater manufacturer."

3.4 DECENTRALIZED COOLING AND HEATING

A. Unitary split systems.

1. Fans/motors.

a. Fans shall be designed and specified to assure stable, non-pulsing aerodynamic operation in the range of operation over varying speeds. AHUs and fans in sizes over 1 hp shall use belt drives.

b. Fans with motors of 10 hp or less shall be designed with adjustable motor pulley sheaves to assist in air balancing of systems. Fans with motors greater than 10 hp shall use fixed (nonadjustable) drives that can be adjusted by substituting fixed motor pulley sheaves of different diameters.

c. Supply AHUs and return air fans in variable air volume systems shall be designed for control of capacity. Fans shall comply with AMCA Standard 201, ASHRAE Standard 51, and ASHRAE Equipment Handbook.

d. Fans/ductwork interface shall be per the requirements of AMCA Publication 201 and ACGIH Industrial Ventilation Manual. Fan system effect factors shall be determined in accordance with AMCA Publication 201 and added to the static pressure for sizing and selecting fans.

e. Spark resistant construction shall be used where required by NFPA.

f. Generally, fan motors 1/2 hp and larger shall be three-phase, 460V, induction type motors. Totally enclosed fan cooled motors are required for unprotected outdoor locations. Generally, open drip proof motors shall be used indoors and in protected outdoor locations. Across the line starting shall be used for motors 100 hp and smaller. Generally, reduced voltage starting shall be used for motors larger than 100 hp. Motors shall be sized to overcome fan inertia at startup and to provide bhp requirements of the load plus drive losses. Motors shall be the high efficiency type. Insulation class and temperature rise shall be selected for the ambient temperature at which the motor is to operate at the specified service factor.

g. Centrifugal-type fans with backward inclined or airfoil non-overloading wheels are preferred.

h. Bearings shall have a minimum L-10 life of 80,000 hrs. as defined by American National Standards Institute (ANSI)/Anti Friction Bearing Manufacturer's Association Standard II.
i. Bearings shall have fittings for lubrication and relief. Pipe extensions and fittings shall be provided to allow lubrication of equipment without removal of the safety guards.
j. Belt drives shall be designed in accordance with engineering data developed by the drive industry. Designs shall include overload service factors and operating conditions in determining the total percentage above fan motor nameplate horsepower; 140% is a minimum for any application.
    1) Safety guards shall be provided in accordance with SMACNA Standards and OSHA requirements to enclose the exposed sides of moving parts, including, but not limited to, couplings, sheaves, shafts, and belts.
    2) Tachometer openings with removable covers shall be provided for measuring driver and driven shaft speeds without removing the safety guard.
k. The entire project is considered to be a "special application" requiring especially-low vibration levels. Assemblies shall be dynamically balanced to a minimum of Grade 2.5 or better per ASA S2.19.
l. Vibration isolation bases shall be provided for rotating equipment. Isolators shall generally be limited to a transmissibility of 1% in all areas.
m. All fan motors shall be equipped with shaft grounding rings to reduce bearing maintenance costs.

2. Condensers/condensing units.
    a. Water cooled condensers shall comply with and be selected in accordance with ASHRAE Standard 15, ARI 450 and ASME Boiler and Pressure Vessel Code, Sect. VIII.
    b. Water cooled condenser shell and tube types shall be designed and specified with removable heads.
    c. Air cooled condensers and condensing units shall meet the standards, rating, and testing requirements of ARI 460 and ASHRAE Standard 20. These units shall not be located on roofs unless required by project criteria.
    d. The design professional shall locate air cooled condenser intakes away from any obstructions that will restrict the airflow and from locations that receive peak solar heat gain.
    e. Air cooled equipment shall be located away from noise sensitive areas, and air-cooled condensers shall have refrigerant low head pressure control to maintain satisfactory operation during light loading.
    f. The use of once through process or sanitary cooling water is prohibited at ORNL. Use cooling towers, dry coolers, air cooled condensing, etc.
    g. Condensing unit specifications shall prohibit the use of anti-short cycle compressor run time accessories which require manual reset by operation of the main power disconnect switch.

B. Auxiliary components.
1. Heat generating equipment.
    a. A building heat generation system shall not be provided unless one of the following conditions exists:
        1) Connection to the central plant distribution system is not cost effective.
        2) The central plant has insufficient capacity to accept the building load.

3) The use of the building precludes connection to a potentially interruptible central system.

2. Electrical heating coils.
   a. Electrical heating coils shall have low mass, exposed wire heating elements, unless hazardous or corrosive atmospheres require enclosed, finned tube elements.
   b. Electrical heating coils shall be protected with automatic and manual reset type snap disc or bulb type safety devices in both the power and control circuits. A sail switch or other airflow sensor shall be interlocked with the fan and a visual alarm. See Section 01 86 26, Electrical, for additional information on protective devices.
   c. Heating coils operating on 120 and 240V power shall be controlled by single or multistage line voltage thermostats. Heating coils operated on 480V power shall be controlled by a temperature sensor coupled with a time proportioning switch, step controller, and electrical contactors, or SCR controller if precise control is required.
   d. Controls, such as contactors, step and proportional controllers, time proportioning switches, disconnects, pressure electric switches, SCR controllers, and differential pressure switches, shall be installed in accessible, visible locations outside the duct heater enclosure.
   e. Coils shall bear a UL label (preferred) or state that the have been manufactured in compliance with UL design criteria and production requirements, and could bear the UL label if they were assembled with a UL tested and approved contactor and/or with a flow sensing device installed by the duct heater manufacturer."
3. Refrigerant piping.
   a. Split refrigeration systems shall have a complete refrigerant diagram prepared on the drawings. The diagram shall include line sizes and approximate location of a refrigerant specialty including access ports/valves, shut off valves, expansion valves, filter dryers, etc.
   b. A bill of material, including a description and a manufacturer's catalog number, shall be prepared on the drawing for each refrigerant component.
   c. Refrigerant piping shall be sized and configured in accordance with the ASHRAE Refrigeration Manual.

3.5 AIR DISTRIBUTION SYSTEMS

A. Ductwork.
1. All sizes, materials, construction, and support systems shall be designed in accordance with the ASHRAE handbooks, SMACNA, and Company engineering standards.
2. Ductwork systems shall be designed to meet the leakage rate requirements of Sheet Metal and Air Conditioning Contractors National Association (SMACNA) HVAC Air Duct Leakage Test Manual.
3. The routing of ductwork shall be directed to reduce air resistance unless additional turns would be beneficial in reducing the noise transmission from mechanical equipment or between adjacent rooms of the building.
4. Single-wall, internally insulated ductwork shall not be used.
5. Round elbows shall have a minimum turning radius of 1½ duct diameters.
6. Mitered elbows with turning vanes should be used only where space is limited.
7. The use of computerized duct sizing methods is encouraged to obtain economical designs and the benefits of sizing ductwork by the static regain method.

8. Access doors shall be installed at:
    a. Fire dampers for servicing spring latches and fusible links.
    b. Both air entering and leaving sides of cooling and heating coils.
    c. Air entering side of multi-blade balancing dampers.
    d. Locations requiring periodic inspection, adjustment, and/or maintenance.
    e. Locations shown on the drawings.

B. Ductwork accessories.
1. All supply air outlets and return or exhaust intakes shall achieve the specified noise levels in the spaces served. Anti-smudge type air diffusers with fixed cones designed to discharge air horizontally along the ceiling are preferred. Air turning and straightening devices shall be provided for supply air outlets where space is available. Opposed blade volume control dampers shall be provided for supply, return, and exhaust outlets for system balancing.
2. Weather caps shall be constructed in accordance with SMACNA and ASHRAE guidelines.
3. Stacks shall be supported independently of associated equipment.
4. Flexible connections shall be provided between motor driven equipment and the stacks.
5. Instrument test openings shall be provided for Pitot tube traverses in accordance with ASHRAE Standard 111.

C. Terminal equipment.
1. Variable air volume boxes and fan-powered variable air volume boxes.
    a. Zone thermostats or temperature sensors and controllers initiate adjustment of a volume-regulating device in the VAV boxes changing the supply airflow rates as required to maintain the space set point temperature.
    b. Reheat coils in the VAV terminal boxes provide perimeter heat.
    c. Calculation of minimum airflow to a zone shall consider minimum ventilation rates in the zone in accordance with ASHRAE guidelines, exhaust air requirements for the zone, and minimum air movement in the zone.
    d. The outside air damper shall be closed during warm up and unoccupied periods.
    e. Specify high entrainment types of outlets to achieve higher air velocity at minimum flow.
    f. Automatic controls should be used in VAV systems to assure a constant/minimum amount of outside air to comply with ventilation codes.
    g. Installation of VAV boxes shall allow for ease of maintenance, inspection, testing and checkout.
        1) Preferred location of VAV air terminal units is above corridor ceilings.
        2) Locate VAV units at least three feet from all walls whenever installation above office ceilings is required.

3.6 EXHAUST, RETURN AND OUTSIDE AIR VENTILATION AND FILTRATION SYSTEMS

A. General.
1. Design exhaust outlets per ASHRAE Fundamentals and to preclude exhaust to intake return of exhaust air into a facility. See paragraph 3.1.C for exhaust stack designs.
2. Minimum outside air requirements for ventilated and air-conditioned occupied spaces shall be as specified in ASHRAE 62 and the project criteria.

3. Spaces shall be maintained under slightly positive pressure with respect to the atmosphere except for toilets, rest rooms, change houses, and similar areas shall be maintained at a negative pressure with respect to adjacent areas. Laboratories and process buildings using hazardous materials may be required to be held at a negative pressure with respect to the atmosphere.
4. Exhaust stacks and fresh air intakes shall be located where incoming air will be free of exhaust effluent gases and particulates such as grass cuttings and cooling tower drift. Debris screens shall be accessible for cleaning. Intake air velocity shall be less than 500 fpm.
5. See paragraph 3.1.C for exhaust stack design related requirements.
6. Ductwork shall comply with NFPA 91.
7. Ductwork constructed of aluminum should be considered for air exhausted from shower rooms, dishwashing areas, or other areas causing condensation on the duct interior, and have drainage at low points.
8. Rest rooms, janitor closets, garbage rooms, and other malodorous spaces shall be exhausted at a rate of not less than 2 cfm/ft2 or as specified in ASHRAE Standard 62, whichever is the more stringent, regardless of any other calculated ventilation requirements.

B. Return
   1. If the indoor air quality does not meet or exceed the limits given in ASHRAE Standard 62, the re-circulated air must be treated and monitored.
   2. Areas from which air shall not be re-circulated include areas that produce or emit dust particles, heat, odors, fumes, spray, gases, smoke, or other contaminants that cannot be sufficiently treated and could be potentially injurious to health and safety of personnel or are potentially damaging to equipment. These areas shall be 100% exhausted. Project criteria shall indicate other areas of non-recirculation.

C. Particulate air filtration.
   1. Selection of an air cleaning device for a given particulate shall be based on the recommendation of the ASHRAE Equipment Handbook. MERV 13 filtration media is required for Construction IAQ Management.
   2. Air cleaning equipment for ductwork installation shall be easily removable, serviceable, and maintainable. Air cleaning equipment shall have face velocities as recommended by the filter manufacturer to achieve maximum efficiency and minimum pressure drop.
   3. Filters shall be constructed of noncombustible materials meeting the requirements for UL 900 Class I. Air filters shall be located on the suction side of fans and coils and in other special locations as required for air treatment. Air filter pressure drop gages of the diaphragm actuated, dial type (preferred) or the inclined manometer type shall be located on filter assemblies. Electronic pressure drop sensors shall be provided and shall be capable of direct communication with the ORNL campus standard Johnson Controls Metasys building management system.
   4. HEPA filtered systems shall comply with Engineering Standard ES-5.16-1 and as noted in Section 01 86 19.2 HEPA filters.
   5. Low through high efficiency filters.
      a. All pre-filters shall conform to the requirements of ARI 850, Group III Filters and UL 900, Class 1or 2. Pre-filter efficiencies for the following filter classifications shall be in accordance with ASHRAE Standard 52.1.
         1) Low efficiency (roughing): 5 to 25%.

2) Medium efficiency: 25 to 75%.
3) High efficiency (not HEPA): 75 to 95%.

b. Pre-filters shall be dry fibrous.
c. When pre-filters are installed to protect HEPA filters, they shall be rated at a minimum of 80% efficiency based on ASHRAE 52.1 and shall be UL900, Class 1.
d. Air filter banks shall be designed for replacement of elements from the air entering side unless otherwise noted.
e. Side loading retainers or other commercially available housings may be used for medium and high efficiency filter systems of up to three filters high by four filters wide.
f. Filter selections shall be based on the lowest efficiency range compatible with the area or system requirements. This does not apply to LEED facilities where MERV 13 filters are required.
g. A photometal tag or other suitable ID tag shall be installed on filter banks.

6. Air-cleaning devices for special applications.
   a. Filters such as dry type dust collectors, wet collectors, centrifugal collectors, adsorbers, absorbers, oxidizers, and chemical treatment filters that are used primarily in industrial and process type applications will be described in the project criteria.
   b. Absorbers for nuclear or toxic applications shall comply with the DOE Nuclear Air Cleaning Handbook and ASME AG-1.

3.7 HVAC CONTROL SYSTEMS

A. General.
1. Special control requirements shall be indicated in the project specific criteria.
2. All control equipment shall be easily accessible. One temperature control panel shall be provided for each system, complete with panel face mounted indicators, switches, pilot lights, and tags. Control interlocks shall be through hands off-automatic (HOA) switches.
3. Control air compressors shall be duplex non-lubricated type with oil lubricated crankcase and distance piece. Air shall be filtered and dried using refrigerated air dryers for dew point of 15°F and regenerative silica type for dew point below 15°F.
4. Copper piping shall be used for high pressure air in inaccessible locations. Transmitters shall be capable of field calibration and thermometers, or pressure gages shall be provided at transmitters. Controllers and thermostats shall be pilot bleed type.
5. Instrument and control specifications shall be prepared for each item. A master instrument index shall be used to locate instruments and their respective specifications.
6. Automatic shutoff/on controls with manual override shall be provided where practical.
7. Provisions shall be made for fail safe operation in case of emergency.
8. Control system drawings and specifications shall be detailed sufficiently to allow installation of the entire system by a contractor without additional engineering. Notes shall be shown in a legend on the drawing. Drawings shall include a sequence of operation for each system.

B. Zoning.
1. Zoning for automatic control of space temperatures, static pressures, humidity, ventilation, smoke and fire detection, security, and lighting shall satisfy health and safety requirements as indicated in the project criteria, NFPA 101, space operational and

occupancy requirements, and zoning exposure with relation to building size, orientation, and configuration.

2. Each HVAC system shall have a separate thermostat for space temperature regulation and a separate humidistat if humidity control is provided.
3. No zone shall contain more than a single building floor regardless of floor space.
4. Automatic controls shall be provided to shut off heating or cooling to any individual zone.
5. Interior zones shall not be combined with external zones.
6. Interior space zones and external zones shall be served by separate equipment.
7. External space zones shall be selected for each individual exposure.
8. For office facilities and similar occupancies, each major orientation shall be zoned to have no more than 2,000 ft2 of floor area with exterior exposure and no more than 3,000 ft2 of floor area without exterior exposure.
9. HVAC design of small conference / huddle rooms shall account for the additional ventilation required to accommodate fresh outside air and maintain temperature control for the maximum number of occupants possible, personal electronic devices and potential near future A/V installations.

C. Control setback and shutoff devices.
   1. Provide control setback, manual override, and shutoff functions in the Metasys Building Management System, BMS.

D. Humidity control.
   1. No controls shall be provided to dehumidify spaces to below 55 +/- 5% relative space humidity or to humidify spaces to greater than 30% relative space humidity unless required on a project specific basis and as stated in the project criteria.

E. Control of air-handling systems.
   1. Mechanical ventilation control.
      a. The BMS shall be provided with the feature to control all supply, return, and exhaust ventilation systems to shut off the fan when ventilation is not required.
      b. Systems that circulate air shall be provided with minimum outdoor air damper position control to assure that the minimum outdoor air quantity is being introduced to the system.
      c. Automatic dampers should fail open for return air and fail closed for outside air.
   2. Outdoor cooling, control (economizer cycle).
      a. All air handling systems shall be designed to automatically use outside air quantities up to 100% of the fan system capacity for cooling the space.
      b. The economizer cycle control system shall have a reset feature.
      c. The economizer cycle control system shall be designed with a relief air control cycle to positively relieve the supply air from the space by sequencing return or relief fans or dampers to maintain a constant room static pressure.
      d. Systems using the economizer cycle should be provided with adequate air filtration to handle the quality of the outside air.
   3. Automatic control dampers.
      a. Automatic air control dampers shall be specified to be the low leakage type with a maximum leakage of 6 cfm/ft2 at maximum system velocity of 1500 fpm and 1 in. pressure differential.
      b. The dampers shall be opposed blade type for modulating control.

c. Dampers shall be sized for at least 20% of the total ductwork resistance pressure drop.
d. Pilot positioners and operators shall be located out of the airstream.

4. Variable air volume system fan control.
   a. Variable air volume systems shall be designed with control devices to sense ductwork static air pressure and velocity air pressure and control supply fan air flow and static pressure output through modulation of variable inlet vanes, mechanical speed drive controls, or variable frequency electric drive controls.
   b. Exhaust fans, supply fans, and return or relief fans shall have control devices that interface the operation of the fans to "track" air volumes and maintain fixed minimum outdoor air ventilation requirements.
5. Fire and smoke detection and protection controls.
   a. Engineered smoke pressurization and evacuation systems shall comply with the following:
      1) NFPA 90A.
      2) NFPA 72.
      3) ASHRAE Manual, Design of Smoke Control Systems for Buildings.
      4) ASHRAE Systems Handbook.
   b. All air handling systems shall be provided with the smoke and fire protection controls required by NFPA 101.
6. Gas fired air handling unit control.
   a. Gas burner and combustion controls shall comply with Factory Mutual Loss Prevention Data Sheets and be listed in the Factory Mutual Approval Guide. Gas fired AHUs shall be specified with controls to lock out the gas supply in the following conditions:
      1) Main or pilot flame failure.
      2) Unsafe discharge temperature (high-limit).
      3) High or low gas pressure.
      4) No proof of air flow overheat exchanger.
      5) Combustion air loss.
      6) Loss of control system actuating energy.
      7) Control of chilled water and hot water distribution systems.
   b. Zone control/distribution system control.
      1) Each zone or air handling system shall be designed with individual terminal unit valve control.
   c. Control valve selection.
      1) Temperature control valves shall be either two-way or three-way, two position or proportioning type valves. Valves controlling modulation shall be equal-percentage proportioning valves.
      2) Control valves shall be sized for a 5-psi pressure differential across the valve or a pressure differential of 50% of the combined branch piping and coil pressure drop, whichever is greater.
      3) Control valves shall use either pneumatic, electric, electronic, or self-contained controllers.
      4) Valves in cooling and heating systems shall be fail-safe.
      5) Valve operators shall be selected to close against pump shutoff head for two-way valves and one-half pump shut off head for three-way valves.
      6) Set points shall be selected to maintain either a fixed space temperature or a fixed coil discharge temperature.

d. Load control for hot water systems.
   1) The supply delivery temperature shall be reset based on the temperature outside.
e. Load control for chilled water systems.
   1) Central station cooling equipment shall modulate to control capacity.
   2) Central station cooling equipment shall be provided with controls to limit the current draw of the cooling equipment in periods of high electrical demand.

F. Building Management Systems (BMS) and Direct Digital Control (DDC) system.
1. Design basis shall be Johnson Controls, Inc. (JCI) controls equipment compatible with the Metasys BMS.
2. Design documents shall require the system supplied to communicate with the current ORNL campus wide BMS's, JCI Metasys M5 from the ORNL intranet.
3. Design shall specify BACNet Level 4 (web based) compliant DDC equipment, compatible interface devices and programming to access and control the BMS from remote workstations with approved web browsers and connection to the ORNL intranet (Ethernet) system.
4. The design professional shall design permanent metering when required in accordance with the project specific criteria in Section 01 86 19.1.
5. Permanent sub-metering shall be considered and implemented for each type of process energy consumed in new buildings and facilities owned and leased by DOE as indicated in the project criteria.
6. Control software shall include Optimum Start/Stop, Scheduled Start/Stop, Night Purge, Night Setback, Chiller Optimization, Tower Optimization, and Chilled Water Reset.
7. The BMS/DDC system shall not interfere with or override any safety feature on any HVAC system. The HVAC system discharge temperature, space temperature, fan differential pressure, and filter differential pressure shall be monitored by the BMS.
8. All facility fans shall be designed and installed for automatic start and stop operation from the BMS. Provide local hands-off-automatic switch pushbutton control and indication light at each fan installation.
9. The Seller shall be responsible for providing BMS/DDC system testing, checkout, installation of wire, conduit, sensors, relays, switches, etc.
10. Specify all energy meters to include MODBUS IP as a required output capability.

3.8 SPECIAL HVAC SYSTEMS

A. Building Distribution Facility (BDF) and/or telecommunication rooms.
1. Provide adequate cooling for lights and personnel and ¾ ton of cooling to offset heat generated by networking and other telecommunication equipment.
2. The cooling systems for the BDF room and telecommunications closets shall be stand alone units and shall be supplied from an emergency/standby generator, if emergency/standby power is available at the facility.
3. Provisions shall be made for the Building Management System (BMS) to monitor the temperature of the BDF room and telecomm rooms and provide alarm indication if temperature exceed allowable limits.

END OF SECTION 01 86 19

SECTION 01 86 26 – ELECTRICAL

PART 1 - PROJECT REQUIREMENTS

The Building 3625 South Addition creates building space and infrastructure for a new microscope suite per the Work Scope. The electrical system associated with the South Addition project is an upgrade and extension of existing facility infrastructure to support the increased building space.

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. Drawings of existing facilities and utilities are provided for reference.

PART 2 - CODES AND STANDARDS

2.1 STANDARDS AND SPECIFICATIONS

A. Work Smart Standards referenced in Section 01 41 00 apply to this Section.

B. This document contains references to the general codes, standards, procedures, specifications, and technical definitions that are applicable to the design work to be performed, to the electrical equipment and materials to be furnished, to the methods of installation, to the requirements for inspection and testing, and to acceptance criteria. Requirements of the latest editions shall apply.

1. American National Standards Institute (ANSI).
2. Code of Federal Regulations (CFR).
3. Factory Mutual Engineering and Research Corp.
4. Illuminating Engineering Society of North America (IESNA).
5. Institute of Electrical and Electronic Engineers (IEEE).
6. National Electrical Manufacturer's Association (NEMA).
7. National Fire Protection Association (NFPA).
8. ORNL Electrical Engineering Standards.
9. Underwriters Laboratories Inc. (UL).

C. ORNL Electrical Engineering Standards.

1. See Project Wise.

PART 3 - TECHNICAL REQUIREMENTS

3.1 GENERAL DESIGN REQUIREMENTS

A. Electrical safety shall be the foremost consideration in the design of all facilities and equipment.
   1. Consideration shall be given to the electrical design to minimize the necessity of working on or near energized parts and equipment during construction, operation, and maintenance activities.
   2. The design shall mitigate excessive arc flash hazards at all electrical equipment with special consideration given to those that typically exist at the secondary of transformers. This shall be accomplished by providing overcurrent devices at transformer secondaries that utilize static trip circuit breakers or fusible disconnects that include current limiting fuses.

B. Electrical design shall be in accordance the National Electrical Safety Code (IEEE C2), the National Electrical Code (NFPA 70) and other applicable National Fire Protection Association codes, Occupational Safety and Health Act (OSHA) standards, and any other applicable codes and standards. Materials and utilization equipment shall conform to applicable ANSI, IEEE, NEMA, NFPA and UL standards.

C. Design analysis and calculations.
   1. Calculations shall include but are not limited to the following:
      a. Short circuit currents.
      b. Arc flash hazard analysis (select a specific equipment manufacturer as a design basis).
      c. Connected load, demand load, demand factor, and diversity factor for overall building and for emergency standby and uninterruptible loads.
      d. Voltage drop.
      e. Conductor ampacities.
      f. Lighting foot-candle level.
      g. Electric heat tracing (including in rush current).
      h. Raceway/cable tray sizes.
      i. Pull/junction box/enclosure sizes.
      j. Cable bending radius.
      k. Conduit sizes.
      l. Grounding and bonding conductor sizes.
   2. Hard copy and electronic files (in native format) for calculations and design analysis shall be provided.
   3. SKM Power Tools software shall be utilized for short circuit, and arc flash hazard analysis. The complete SKM model shall be provided to ORNL.
      a. Ensure that the name of each component in the SKM model is the same on the one-line diagram that's part of the construction document package.
      b. Provide an arc-flash specification that shall include the requirement for the contractor to update the SKM model using the specific electrical equipment provided and other as-built characteristics of the electrical system. The updated assessment shall be performed by a qualified professional engineer. If an equipment vendor performs the assessment, it must be stressed that the model

needs to encompass the entire electrical system that includes local disconnects, mechanical equipment, etc.

c. Specifications shall include the requirement for the contractor to install arc flash hazard warning and danger labels that include the information from the arc flash hazard assessment. A standard ORNL label format is required which will be provided.

d. This updated assessment shall also include an overcurrent device coordination study which shall incorporate the mitigation of arc flash energy levels to the maximum extent possible.

e. Hard copies and the updated SKM model (complete native files) shall be provided to the Company.

D. One-line diagrams.

1. A one-line diagram of the modified electrical system shall be provided. A riser diagram may also be provided but a riser diagram in lieu of a one-line diagram is not acceptable.

E. Working clearance detail.

1. Provide a detail that illustrates the required depth and width of working space around electrical equipment in accordance with NFPA 70, Article 110.26 and 110.34.

F. Electrical load, demand factors and diversity factors.

1. Electrical load, demand, and diversity factor calculations shall be prepared for each new facility and shall be performed in accordance with chapter 2 of IEEE 241, Electric Power Systems in Commercial Buildings and chapter 2 of IEEE 141, Electric Power Distribution for Industrial Plants. Feeder and service calculations shall comply with Article 220 of NFPA 70.

G. Electrical energy usage metering.

1. Metering shall be provided at each facility’s service entrance equipment and emergency/standby power sources. Meters shall be Schneider Electric / Square D PM8000 with display. Meters shall be installed and configured to manufacturer specs, to include verification of correct wiring connections utilizing on-board phasor diagram. Configuration of meters shall include setting of proper system frequency, volts mode/system type (3W Delta, 4W Wye, etc), PT ratio, and CT ratio for the service being metered.

2. There shall be an upstream breaker or disconnect to allow isolation of electrical energy to meter, including the cabinet or enclosure in which it is installed, such that the meter may be serviced without having to disconnect power to other facility electrical circuits in order to achieve electrical isolation to the meter and its enclosure/cabinet.

3. Ethernet communication cabling shall be provided to each meter and be of Cat5e performance or better. One end of the communication cable shall be terminated and connected to the meter Ethernet port. The communication cable leaving the metering enclosure/cabinet shall be routed in conduit until reaching an above-ceiling communication cable tray and/or entering the telecommunication room where the Energy Management and Control System (EMCS) ethernet network switch is located. Communication cables shall be a continuous run of cable between the meter’s ethernet port and the EMCS network switch or to a patch panel located in the telecommunication room. Couplings, splices, secondary switches, wall jacks, etc. are not acceptable in the routing of cable between the meter and the telecommunication room.

3.2 POWER DISTRIBUTION SYSTEMS

A. Consideration shall be given to supplying a main breaker ahead of the electrical gear that contains the facility main service equipment to reduce arc flash levels within the main service equipment and to provide isolation to the main service equipment without a utility outage.

B. Series rated equipment
   1. Series rated equipment shall not be utilized.

C. Circuit breakers
   1. Static trip circuit breakers shall be supplied throughout the electrical system where the use of such breakers will be beneficial to reduce arc flash hazards.

D. Medium voltage transformers.
   1. Medium voltage transformers will be supplied by ORNL Utilities Division.

E. Medium voltage switchgear.
   1. Medium voltage switchgear will be supplied by ORNL Utilities Division.

F. Low voltage metal-enclosed switchgear.
   1. No distribution 1600 amps or greater is anticipated.

G. Distribution switchboards.
   1. In general, low voltage distribution switchboards may be utilized as service entrance equipment if sized at 1200 amperes or less. See this section for metering requirements.

H. Distribution panelboards.
   1. 480V distribution panelboards may be utilized as service entrance equipment if sized at 800 amperes or less. See this section for metering requirements.
   2. The (continuous demand load x 125%) plus (non-continuous demand load) shall not exceed 75% of the panelboard's rated capacity.
   3. Busbar bracing and device Ampere Interruption Ratings shall meet or exceed available fault current as calculated in Section 3.1 C.3
   4. Provide 30% spare breaker mounting space for future loads.

I. Panelboards.
   1. Panelboards shall be provided with copper buses and bolt-on circuit breakers.
   2. The (continuous demand load x 125%) plus (non-continuous demand load) shall not exceed 75% of the panelboard's rated capacity.
   3. Provide 30% spare breaker mounting space for future loads.
   4. Panel schedules shall be provided for each panelboard and shall indicate which circuits require ground fault protection (equipment and personal), shunt trip, etc.

J. Absence of Voltage Testers
   1. New 480V service entrance and major distribution switchgear, switchboards, and panelboards shall be fitted with Absence of Voltage Testers such as Panduit VeriSafe. Display modules shall be located on panel fronts such that they are readily visible for inspection, and do not interfere with internal cables.

K. Motor control
1. Motors ½ HP and larger shall be supplied by 480V.
2. Single phase motors may be controlled manually by devices of adequate rating. Three phase motors greater than 1 HP shall have magnetic starters.
3. Control devices shall be of adequate voltage and current rating for the duty to be performed. Control circuits shall operate with one side grounded, at 24V preferred, but no greater than 120V.
4. Motor starters for 480V motors 50 HP and smaller shall normally be across the line full voltage starting type. For motors that require frequent starting, variable frequency drives (VFD's) shall be considered for soft starting.
5. For motors over 50 HP, a motor starting study shall be performed to determine the best solution.
6. All 480V, three phase, 60-Hz motor control centers (MCCs) shall be NEMA 1, Class B.

L. Low voltage transformers (600V).
1. Interior step-down low voltage transformers (480:120/208V; 480:120/240V; etc.) for lighting, receptacle and miscellaneous loads shall be dry type, floor or wall mounted, with a minimum of four full capacity 2-1/2% taps, with two taps above and two taps below rated voltage.
2. Transformers shall be copper or aluminum wound, 115° C temperature rise with 220°C insulation.

M. Interior distribution voltage levels.
1. Power shall be distributed at 480Y/277V three phase, four wire, grounded; 208Y/120V, three phase, four wire with grounded neutral; and/or 120/240V, single phase with grounded neutral. A grounded conductor (neutral) shall be routed to all service entrance equipment served by a grounded system.

N. Power quality requirements.
1. Power requirements of the new microscope shall determine the need for uninterruptible power supplies, isolation transformers, or power conditioners.

O. Electrical distribution equipment identification.
1. In each building or facility, equipment that distributes electrical power (480V switchgear, 480V motor control centers, 480V panelboards, electrical plug-in busways, distribution switchboards, distribution racks, load centers, lighting and power panelboards; etc.) shall be identified with a unique designation number.
2. The designation number shall consist of voltage (H=480, L=208V); N (normal) or E (emergency or standby); floor or level (B, G, 1, 2… R); and designation letter (A through Z).
3. Each piece of electrical distribution equipment (switches, starters, panelboards, receptacles, etc.) shall be clearly marked with the voltage, number of phases, source of supply (panel and circuit; etc.), and where applicable, the equipment being served.

3.3 EMERGENCY AND STANDBY POWER SYSTEMS

A. Emergency power systems.
1. Emergency power is not required for this addition.

B. Standby power systems.
   1. If deemed necessary, standby power systems shall comply with Articles 701 and 702 of NFPA 70. The systems shall supply power to selected loads such as heating and refrigeration systems, data processing and communication systems, ventilation and smoke removal systems, sewage disposal systems, lighting systems, and industrial processes, that when interrupted during a power outage, would create hazards, damage to product or process, or severe monetary loss.

C. Packaged diesel generator sets and automatic transfer switches.

   If a diesel generator set is deemed necessary:
   1. Generator sets are an ORNL standard item, specified by specification 16 32 13.01, manufactured by Caterpillar.
   2. The Company will prepare and submit an air permit to the Tennessee Department of Environment and Conservation (TDEC). Generators cannot be delivered to ORNL until the permit is approved by TDEC, which typically requires 60 days. Specifications shall make this delayed delivery requirement know to the Seller. Specifications shall also require the manufacturer to provide a Certificate of Conformity that the engine conforms to EPA requirements.
   3. Emergency and standby power generators shall be exterior concrete pad mounted, diesel engine-generator type, and shall include a weatherproof enclosure, integral UL listed sub-base double wall fuel tank with leak detection, battery, battery heater, battery charger and starting system, exhaust silencer, jacket heater, output circuit breaker, microprocessor-based control panel and remote annunciator panel.
   4. Generators shall be provided with permanently installed load banks sized in accordance with NFPA 110.
   5. For generators that serve emergency loads, provide a permanent switching means to connect a portable generator in accordance with NFPA 70, Article 700.
   6. Automatic transfer switches shall be manufactured by Russelectric.
   7. Maintenance access platforms shall be provided for generators that, due to the height of the integral fuel tank, cannot be maintained from grade level. Generators that include a walk-in housing do not require access platforms.
   8. Generators shall be connected by Modbus to the building automation system (Johnson Controls - Metasys). Generators shall include a local annunciator panel.

D. Uninterruptible power systems.
   1. Uninterruptible Power Sources (UPSs) shall be provided for those loads requiring guaranteed continuous power. Installation shall comply with NFPA 70.
   2. UPSs shall be installed in accordance with NFPA 855, Standard for the Installation of Stationary Energy Storage Systems.

3.4 LIGHTING SYSTEMS

A. General.
   1. Exterior lighting systems.
      a. Exterior lighting shall comply with the IESNA Lighting Handbook, and applicable Recommended Practice (RP) manuals. Exterior street lighting and bollard fixtures shall be standard ORNL assemblies using LED fixtures.

b. Photocell or astronomic time clock control shall be implemented to control nighttime illumination. Provide lighting contactor(s) for installations involving multiple luminaires rather than individual photocells at each luminaire.

2. Interior lighting systems.
   a. Interior lighting shall comply with the IESNA Lighting Handbook.
   b. Interior fixtures shall be LED type for all applications where LED type fixtures are readily available.
   c. Light loss factors for LED fixtures shall be based on the manufacturer's 10-year depreciation output. LED fixtures shall include the proper light loss factor when located in high heat areas.

B. Lighting circuit voltage levels.
   1. Interior lighting shall operate at 120V. Exterior lighting luminaires shall typically be served by 208V, 240V or 277V circuits. Luminaires and installation shall be in accordance with NFPA 70.

C. Illumination levels.
   1. Lighting calculations shall be prepared for each area. Unless provided in other programming information, lighting level in each interior area shall be in accordance with IESNA. Exterior lighting levels shall be based on high security areas.

D. Lighting controls.
   1. All offices, laboratories and other rooms with floor to ceiling partitions shall have individual lighting controls. Multi-level switches, occupancy sensors, timers, photoelectric (PE) controls, or other energy saving means shall be provided. Task lighting and local lighting for occasional use, such as for maintenance tasks, shall have local switches. Conventional wiring devices shall be commercial specification grade.
   2. For facilities where lighting control panels may be suitable, the control panels shall include an astronomic time clock, Photocell input, and bypass/override input capability.

E. Lighting circuits.
   1. Wiring for lighting circuits shall be run in conduit. Type MC-cable may be used above suspended grid ceilings.

F. Exit (indicating) lighting.
   1. Exit lighting fixtures shall be provided to indicate building exits. Exit lighting shall comply with NFPA 101 and NFPA 110.

G. Emergency egress lighting.
   1. Emergency egress lighting systems shall comply with NFPA 101 and NFPA 110.
   2. Exterior emergency lighting shall be provided at personnel exit doors.
   3. Battery packs that are integral to LED light fixtures shall be rated 1400 lumens minimum.

H. Personnel entrance lighting.
   1. All exterior personnel entrance doors shall be illuminated.

I. Lighting circuit identification.
   1. Electrical service for exit indicating fixtures shall be supplied from a dedicated circuit. These circuits shall be clearly identified on panel directories as supplying emergency lighting.

3.5 GROUNDING AND BONDING

A. General.
   1. A grounding electrode and triad system exists for the current microscope systems. New grounding and bonding elements for electrical systems, building structural steel, and facility equipment, shall be provided and installed per NFPA 70.
   2. Where utilized or required, ground buses and ground floor inserts, metal fences and gates, outdoor structures and pipelines, shall be grounded.
   3. Grounding and bonding systems designed and installed in accordance with NFPA 70 are intended to protect equipment and personnel. Additional consideration shall be given to installations involving sensitive electronic equipment and networks, including the particular requirements of the new microscope system.
   4. Grounding grids, triads, loops, ground buses, etc., shall be tested by the contractor using the fall of potential method in IEEE Standard 81. Test documentation confirming acceptable results shall be included with the building completion package.

B. Grounding triad.
   1. New grounding triads shall consist of a buried No. 2/0 bare copper cable and driven ground rods located outside the perimeter of the building. The cable shall be buried a minimum of 30 in. deep. Driven ground rods shall be 3/4 in. diameter X 10 ft long and be spaced at nominal 10-ft intervals from one another. The grounding triad shall be designed and tested so that the resistance to earth does not exceed 25 ohms.

C. Ground grid.
   1. A ground grid system exists for the current building and microscopes. New grid shall consist of a buried No. 4/0 bare copper cable and driven ground rods located around the perimeter of the building. The cable shall be buried a minimum of 30 in. deep and be located a minimum 18 in. away from the building. Driven ground rods shall be 3/4 in. diameter X 10 ft long and be spaced at nominal 25-ft intervals around the perimeter of the building. The grounding system shall be designed and tested so that the resistance to earth does not exceed 1 ohm.

D. Ground loop.
   1. Provide a minimum of two ground rods, 3/4 in. diameter X 10 ft long, at any new medium voltage transformer, switchgear, etc., and a ground loop consisting of a buried No. 4/0 bare copper cable circling the equipment pad. For medium voltage transformers with a secondary neutral bonded to the transformer enclosure, avoid connection of the ground loop to any facility grounding grid or triad to prevent paralleling of the service entrance grounded (neutral) conductor. Ground loops shall be designed and tested so that the resistance to earth does not exceed 5 ohms.

E. Single point grounding systems.
   1. A single-point grounding system exists for the current microscopes.

F. Grounding electrode conductor and bonding jumpers.
   1. The size for new grounding electrode conductors and bonding jumpers shall be, as a minimum, No. 2/0 bare copper or larger, as required by NFPA 70, Article 250. Grounding electrode conductors and bonding jumpers shall be extended from the ground grid or triad to the electrical service entrance equipment, foundation reinforcing steel, structural steel, internal step-down transformers, ground buses, fire alarm master box, and to dedicated telecommunication equipment areas. The secondary neutral of step-down transformers shall be grounded in accordance with Article 250 of NFPA 70.

G. Structural bonding and ground buses.
   1. For facilities that utilize a ground grid, the structural steel shall be bonded at each alternate column by means of a No. 4/0 bare copper cable. Ground buses, as required, shall be connected to the ground grid or triad by means of a No. 4/0 bare copper cable. Ground inserts shall be used where ground cables extending through the surface of the concrete would be exposed to mechanical damage.

H. Equipment grounding and bonding.
   1. Electrical equipment such as panelboards, junction boxes, safety switches, terminal boxes, transformers, etc., shall be grounded and bonded with a dedicated equipment grounding conductor run with the circuit conductors supplying the equipment as stated in Article 250 of NFPA 70. Metallic raceways, enclosure, etc., shall be bonded together to form an effective ground fault current path per NFPA 70, Article 250.

I. Isolated ground systems.
   1. Isolated ground systems may be required to meet special instrumentation or other equipment needs. Such ground systems shall be clearly identified, protected against improper usage, and installed in conformance with NFPA 70.

J. Transient voltage surge suppression (TVSS).
   1. Transient voltage surge suppression shall be provided as a system whereby multiple devices shall be installed at different levels of the power distribution system in order to provide a total coordinated, engineered system.
   2. TVSS shall be provided for all facilities that require lightning protection systems.

3.6 MISCELLANEOUS SYSTEMS

A. Lightning protection.
   1. Extend the existing lightning protection system to new structure. See Fire Protection section for requirements of lightning protection systems for buildings and structures.

B. Electric heat tracing systems.
   1. No new heat trace is anticipated.

C. Cathodic protection.
   1. No underground metallic process piping or vessels requiring cathodic protection are anticipated.

D. Access controls.

Access control equipment exists in the current building.

1. If required, dedicated branch circuits shall be supplied for new access control panels. Additional dedicated branch circuits shall be provided for power supplies serving electric latches and strikes. Power supplies shall be adjacent to the access control panels. Dedicated branch circuits shall be supplied for electric door operators.

E. Audio/Visual infrastructure.
   1. No audio/visual infrastructure is anticipated.

F. Elevators and material handling systems.
   1. No elevators or material handling systems are anticipated.

3.7 EQUIPMENT

A. Conductors and cable.
   1. General.
      a. The color-coding system for branch circuits shall be provided at lighting and power panelboards in facilities where more than one nominal voltage system exists.
      b. Phase conductors shall be identified by circuit number at all accessible locations.
      c. Conductors for interior electrical systems shall be copper. Conductors for power and lighting branch circuits shall not be smaller than No. 12 AWG.
      d. Conductors for Class 1 non-powered limited remote-control and signaling circuits shall be enclosed in conduit and shall comply with NFPA 70.
      e. Conductors for Class 2 low-energy remote-control and signaling circuits shall not be smaller than No. 18 AWG.
      f. Megger tests are required for each 600V cable #4 and larger and may be performed by the contractor or independent testing agency.
   2. Multi-wire circuits.
      a. Multi-wire circuits are not permitted. Where multiple grounded (neutral) conductors are routed in the same raceway, grounded conductors shall be identified with a continuous colored stripe.
   3. Power and lighting cables.
      a. Type MC cable may be used whenever practical in lieu of conduit and conductors in concealed locations in accordance with NFPA 70.
   4. Shielded power cable.
      a. Shielded power cable shall be provided for all motors served by a VFD between the VFD and the motor.
   5. Tray cable.
      a. Wiring installed in cable trays shall be in strict accordance with Article 392 of NFPA 70. Multiconductor cables shall be type TC tray cables in accordance with Article 336 or, when applicable, type PLTC power limited tray cable, Article 725.
   6. Electrical plug-in busway.
      a. Electrical plug-in busway may be used for the distribution of electrical power in areas of concentrated equipment or where frequent modifications are expected.

7. Medium voltage cables.
    a. Medium voltage cables for electrical utilities will be provided and installed by ORNL Utilities Division.

B. Conduit and raceways.
    1. General.
        a. Raceways shall be 3/4-in. minimum in diameter.
        b. Raceways that penetrate fire-rated assemblies shall be selected from the UL Fire Resistance Directory.
    2. Rigid metal conduit and intermediate metallic conduit.
        a. Galvanized rigid metal conduit (RMC) or intermediate metallic conduit (IMC) shall generally be used in industrial areas where conduits are exposed to damage from forklifts, trucks, cranes, etc., or where there is the possibility of leaking oil or water. Galvanized RMC or IMC shall also be used in classified locations and for outdoor and underground installations.
    3. Electrical metallic tubing.
        a. Electrical metallic tubing (EMT) shall generally be used in office and similar areas and also in industrial areas where physical damage is unlikely, typically 10 feet above finished floor. EMT shall not be installed in wet areas, underground, or outdoors and shall not be encased in concrete.
    4. Aluminum conduit.
        a. Aluminum conduit shall be used for high-frequency (HF) circuits where steel will cause magnetic problems or in atmospheres where steel conduit is unsuitable. Aluminum conduit shall not be installed underground, encased in concrete, or where the atmosphere is corrosive to aluminum.
    5. Nonmetallic conduit.
        a. Nonmetallic conduit may be used where allowed by NFPA 70.
    6. Flexible conduit.
        a. Flexible metal conduit shall be used for terminating rigid raceway at motor terminal boxes or other equipment subject to vibration and/or mechanical adjustment. It also shall be used for connection between junction boxes and recessed lighting luminaires.
        b. Liquid-tight flexible conduit shall be used outdoors and indoors where there is the possibility of leaking fluids.
        c. Provide special notation on design drawings to indicate that flexible liquid-tight conduit shall be UL listed.
    7. Cable tray.
        a. Cable trays shall be provided for telecommunication horizontal wiring.
        b. Metal cable trays may be used for the installation of power cables, control cables, communication systems, and similar applications. Separate trays or trays with barriers shall be used to isolate power cables from instrumentation and other low-voltage signal cables.
        c. Cable tray routings shall avoid areas with high concentrations of oil and steam piping. Cable trays shall be spaced to provide a vertical distance of at least 12 in. and a horizontal distance of at least 36 in. between trays. Cable trays that penetrate fire rated floors or walls shall be sealed with a UL listed assembly.

C. Underground conduits.
1. General.
a. All underground conduits shall be installed within a concrete encased duct bank.
b. Underground duct banks shall be topped with red dye (oxide dust) and reinforced per ORNL Engineering Standard ES-8-4. Heavy reinforced duct banks shall be provided under roadways.
c. Underground conduits emerging from grade shall be rigid metal steel, type RMC.
d. Provide a tracer wire for duct banks. See Civil section for tracer wire requirements.
e. Specifications or drawing notes shall indicate that a hold point is required for quality control inspections by the Company before underground duct banks are back filled.
f. The quality control inspection shall require an underground survey (location and elevation) of duct banks to be provided. The specification shall indicate that the underground survey shall be provided by the Seller unless the Company chooses to self-perform the survey.
g. The specifications shall require the Seller to provide accurate red-lined as-built drawings of underground circuits.
2. Medium voltage circuits.
a. Unless coordinated with ORNL Utilities Division, the following conduit size and sweep radiuses shall be provided:
1) Underground conduits for medium voltage circuits shall be 5 inches. Underground conduit sweeps for medium voltage circuits, shall be galvanized RMC and have a 48-inch radius.
3. Telecommunication circuits.
a. Underground telecommunication conduits shall be 4 inches.
b. Underground conduit sweeps for telecommunication circuits shall have a 36-inch radius.

D. Receptacles.
1. General.
a. Receptacles shall be commercial specification grade.
b. Duplex receptacles on 20A circuits shall be rated 20A.
c. As a minimum, 120V receptacles shall be provided in accordance with NFPA 70 and be consistent with established engineering practices.
d. Receptacles shall be labeled with panel name and circuit number.
e. Duplex receptacles installed on finished walls shall be recessed. Duplex receptacles installed in unfinished areas shall be surface mounted in cast boxes.
2. Private offices.
a. Private offices shall have a minimum of one receptacle per wall. Receptacle locations shall be coordinated with furniture layout. Each private office shall be served with a dedicated circuit.
3. Workstations.
a. Workstations (cubicles) shall be provided with circuits on the basis of one circuit per two workstations. Cubicles dedicated to network printers or copiers shall be provided with two dedicated circuits.

4. Break rooms.
   a. Provide a dedicated circuit for each refrigerator, microwave, and commercial multi-burner coffeemaker.
   b. Provide a dedicated 120V, 30A circuits with NEMA 5-30 receptacles for each vending machine.
   c. Provide countertop receptacles in accordance with NFPA 70 requirements for residential kitchens.
   d. Provide a dedicated GFCI protected, switch controlled receptacle under breakroom sinks for a disposal, whether a disposal is being provided or not.
5. Miscellaneous areas.
   a. No conference rooms are anticipated.
   b. Duplex receptacles shall be installed every 25 ft. along corridors in the building. The purpose is to serve janitorial equipment. Open areas, such as cubicle workstations without formal corridors shall be provided with similar receptacles that are not part of office furniture outlet assemblies.
   c. A minimum of one duplex receptacle shall be installed in each rest room.
   d. A minimum of one receptacle shall be provided in each vestibule.
   e. No copier/fax areas are anticipated.
   f. Convenience duplex receptacles shall be provided in electrical rooms, mechanical rooms, janitor's closets, communication rooms, and fire protection riser room. The receptacle in the fire protection riser room shall be GFCI protected.
   g. No records storage areas are anticipated.
   h. Ground fault circuit interrupter protection shall be provided for receptacles as required by NFPA 70.
6. 208V and 240V receptacles.
   a. Single 208V and 240V receptacles shall be provided and located as required, based on equipment to be served in the facility. The number to be supplied by a circuit shall be determined by the demand.
7. 480V receptacles.
   a. Single 480V, three phase receptacles shall be provided and located as required, based on equipment to be served in the individual facility as well as for maintenance purposes. The number of receptacles to be supplied by a circuit shall be determined by the demand. Receptacles shall be pin and sleeve type, rated 600V, 60-A, and shall be compatible with Crouse-Hinds Cat. No. APJ6485 plug. Receptacles shall be provided with [integral/interlocked disconnect switch] [adjacent disconnect switch].
8. Exterior receptacles.
   a. All receptacles in damp and wet locations as defined by NFPA 70 shall be provided with an "in-use" clear acrylic cover that is weatherproof when the attachment plug cap is inserted. GFCI receptacles in damp and wet locations shall be type WR.

E. Motors.
   1. Permanently wired poly-phase motors of 1 HP or more shall be of a premium energy efficient design.
   2. Motors shall have a sufficient rating for the duty they are to perform and shall not exceed their continuous HP rating, including service factor, when the driven equipment is operating at the greatest HP conditions it is likely to encounter. Starting and running

characteristics shall be coordinated with the driven machine and the motor control equipment.

3. Motor enclosures shall be drip proof for indoor dry locations and totally enclosed or totally enclosed fan cooled for outdoor or other wet locations, unless special conditions require otherwise.
4. Variable Speed Drives (VSDs) shall be provided where motor speed requirements vary widely during normal operation or for energy conservation related to heating, ventilation and air conditioning (HVAC) systems. The driven motor shall be selected in accordance with the drive manufacturer's recommendations to ensure a coordinated system and to avoid overheating the motor. Motors shall be premium efficiency, inverter duty rated, and equipped with shaft grounding rings.

F. Cranes and hoists.
1. No cranes or hoists are anticipated.

G. Industrial control panels.
1. Control panels shall meet the requirements of NFPA 70, Article 409, and UL 508A.

H. Electric vehicle charging station.
1. No EV charging stations will be allowed in the vicinity of Building 3625.

I. Neighborhood electric vehicle charging pedestals.
1. Not applicable.

J. Miscellaneous equipment.
1. Disconnects shall be heavy duty, single throw types and shall open all current carrying conductors. Local disconnect switches that are lockable in the open position shall be installed adjacent to the following equipment:
   a. Roof or outdoor mounted fan motors, pump motors, etc.
   b. HVAC equipment (indoor and outdoor), unless the local electrical control panel on the equipment has a main disconnect switch or main breaker that is lockable in the open position.
   c. Pump motors, fan motors, and other motors that are out of sight of or more than 75 ft from the motor controller.
   d. Water heaters, except those operating at 120V in which case a grounding-type receptacle may serve as the local disconnect.
   e. Power distribution and lighting transformers (the primary circuit breaker shall be permitted to serve as the disconnecting means if capable of being locked in the open position).
   f. Procured or shop-fabricated equipment assemblies containing electrical motors, solenoid valves, transformers, control devices, etc., unless the electrical control panel has a main disconnect switch or circuit breaker that is lockable in the open position.
   g. The provisions for locking shall remain in place with or without the lock installed.

K. Inspections and tests.
1. Inspection and testing of electrical equipment, such as motors, switchgear, lighting, power, and distribution panels, power receptacles, power and lighting transformers, wire and cable, new ground systems, etc., shall be provided for in the specifications.

END OF SECTION 01 86 26

SECTION 01 86 27 – COMMUNICATIONS

PART 1 - PROJECT REQUIREMENTS

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

PART 2 - CODES AND STANDARDS

2.1 DESIGN STANDARDS

A. Work Smart Standards referenced in Section 01 41 00 apply to this Section.

B. Additional standards include but are not limited to the following:
1. TIA/EIA-568-B.1, Commercial Building Telecommunications Cabling Standard - Part 1.
2. TIA/EIA-568-B.2, Commercial Building Telecommunications Cabling Standard - Part 2.
3. TIA/EIA-568-B.3, Optical Fiber Cabling Components Standard.
4. TIA/EIA-569-A, Commercial Building Standard for Telecommunications Pathways and Spaces.
5. TIA/EIA-607, Commercial Building Grounding and Bonding Requirements for Telecommunications.

C. Engineering Standards
1. Not applicable.

PART 3 - TECHNICAL REQUIREMENTS

3.1 GENERAL REQUIREMENTS

A. Where required, new cabled Plain Old Telephone Service (POTS), voice over IP (VOIP) telephone system, local area network (LAN), public address (PA) system, security system, and fire alarm system shall be provided in the building and shall be designed to connect to and operate with the existing ORNL systems.

B. Telecommunications circuits and equipment shall be installed to satisfy and tested to verify the requirements in all Division 1 sections and the requirements in room data sheets where provided.

3.2 TELECOMMUNICATION ROOM REQUIREMENTS

A. Telecommunication rooms.
   1. A central telecommunications room exists in the current building. This section applies only to addition of new equipment or new telecommunications room(s).
   2. Intermediate telecommunication rooms shall be installed in the building to maintain horizontal wiring from the telecommunication room to the furthest telecommunication outlet at or below 250 ft.
   3. Telecommunication rooms that include fire alarm panels, security control panels, etc., shall have adequate working clearance for these panels in accordance with NFPA 70.
   4. Equipment racks for patch panels and network equipment shall have 3 feet of clear working space in the front and rear. Assume network equipment will be 30 inches deep so that each network rack will require 8’-6” x 36” of space. Racks shall typically be 45U two post racks with vertical cable management on both sides, front and rear. Rack layout shall be coordinated with the Company.
   5. Rack layout for horizontal ethernet cables shall consist of the following from top to bottom:
      a. 1U 24 port patch panel
      b. 1U space for 48 port network switch
      c. 2U 48 port patch panel
      d. 1U space for 48 port network switch
      e. 2U 48 port patch panel
   6. Network switches shall be provided and installed by the Company.
   7. If multiple floors are involved, telecommunication rooms shall be vertically aligned with two interconnecting 4-inch diameter conduits connecting them.
   8. Rooms that cannot be vertically aligned shall be connected with either cable tray or conduit with capacity equivalent to two – 4 inch diameter conduits. If cable tray used for data drop cable distribution throughout the facility is used for this purpose, it shall be sized to provide spare capacity called for in this section plus unused capacity equivalent to two – 4 inch conduits.
   9. Overhead ladder type cable trays shall be installed to provide proper cable management of telecommunication cables.
   10. A cable tray system shall interconnect the main telecommunication room with other telecommunication rooms located on the same floor or level.
   11. Fire retardant plywood shall be installed on all telecommunication room walls to allow installation of equipment and patch panels. Plywood shall extend from floor to 8’ above finished floor. The plywood shall be installed such that the fire rating label is visible. Once the Company has inspected the plywood installation, it shall be painted white.
   12. Lighting shall be arranged to provide 30 foot-candles (fc) in the aisles between communication racks and walls. Lighting design shall recognize the installation of cable trays, initial and future telecommunication racks. All lighting shall be served by emergency power when available. All lighting fixtures shall be provided with one 1400 lumen battery pack if emergency or standby power is not available.
   13. A rack mounted UPS shall be provided for each network. The UPS shall be a Schneider-APC Model No. SMT3000RM2U with a Model No. AP9630 network interface card. Provide a 120V 30A circuit with a NEMA L5-30R receptacle above the rack. The receptacle shall be served by emergency or standby power when available.
   14. Provide a quad receptacle with two NEMA 5-15 duplex receptacles at each rack served by a dedicated circuit.
   15. A minimum of two convenience receptacles shall be provided in each telecommunication room and shall be served by normal power.

16. Underground telecommunication ducts and conduits extending outside the building to manholes and other facilities shall originate from the main telecommunication room.
17. Grounding provisions shall be made per TIA/EIA-607.

B. See Electronic Safety and Security section for additional requirements.

3.3 CABLE TRAYS

A. Building areas shall be served by an overhead cable tray system where consistent with the existing facility. This system must be accessible for servicing and adding cable.

B. Only ladder type cable tray will be allowed inside telecommunication rooms.

C. Cable trays shall be sized to allow 100% spare capacity.

D. Cable trays shall be located in corridors adjacent to offices and other spaces where data/communications or wireless networking drops will be provided.
   1. The location of cable trays and wire ways shall not be over conference rooms, break areas, restrooms, offices, and other normally occupied areas to avoid having to interfere with room activities when new cables and circuits are installed.

3.4 OUTSIDE SERVICE CABLES

A. Fiber optic cables.
   1. Fiber optic service exists to the current building.

B. POTS cables.
   1. POTS service exists to the current building.

3.5 CIRCUITS WITHIN BUILDING

A. General.
   1. These cables/circuits will be installed by the Seller; detailed A-E design drawings and specifications are required.
   2. See Fire Protection section for additional equipment and for the fire alarm network and fiber optic service from the outside service patch panel to connect the building fire alarm network to the ORNL central fire alarm system.
   3. See Electronic Safety and Security section for additional fiber optic cables required to connect the building alarm and access control systems to the ORNL central security system.

B. Telecommunication room interconnection cables.
   1. Provide one 24 count single mode type OS2 fiber optic cable from each additional telecommunication room to the main telecommunication room. Provide one Corning CCH-01U closet connector housing and two type LC-UPC, Corning CCH-CS12-A9-

P00RJ pigtailed cassettes to terminate the fiber optic cable at each telecommunication room.

2. Coordinate POTS requirements at additional telecommunication rooms with DOE's prime subcontractor, Tyto Athene.

C. Voice and LAN cabling from telecommunication rooms to communication outlets shall be installed by the Seller and shall consist of the following:

1. Voice and LAN cabling shall be one continuous non-spliced, 4-twisted pair, #23 American Wire Gage (AWG) solid copper, UL or ETL Category 6A. Cable shall be installed, terminated, tested, and labeled in accordance with applicable TIA/EIA standards and in accordance with TIA/EIA 568B color code. Test results shall be provided to the Company.
2. Outer jacket color of voice and LAN does not matter. All Category 6A cabling is permitted to have the same jacket color. Cables initially installed for voice service shall be grouped together in patch panels to simplify interconnection with VOIP electronics.
3. Provide 1" diameter metallic conduits from flush data/communication outlets to area above ceiling and terminate conduit with plastic bushing. Leave minimum of one 18" diameter coil of excess cable in ceiling space above each outlet location to allow future re-termination of cable.
4. Coordinate cable placement and lengths for communication outlet location(s) located at modular furniture.

D. Unless noted otherwise on room data sheets, each communication outlet shall have one voice circuit and two data circuits, each modular cubicle office shall have one voice and one data circuit.

E. If more than one communication outlet is to be installed in an office, they shall be installed on opposing walls with the final arrangement reviewed by the Company before completion of design.

3.6 EXTERIOR RACEWAYS AND MANHOLES

A. Install necessary raceways and manholes to provide underground entrance for the outside service fiber optic and POTS cables.

B. All underground conduit shall be schedule 40 PVC, installed within a concrete encased ductbank.

C. Underground ductbanks shall be topped with red dye (oxide dust) and reinforced per ORNL Engineering Standard ES-8-4. Heavy reinforced ductbanks shall be provided under roadways.

D. All conduits emerging from and above grade shall be rigid metallic conduit.

E. Any new ductbanks that serve facilities shall include a minimum of two 4" diameter schedule 40 PVC conduits.

1. All conduits shall be installed with 36" radius sweeping elbows.

2. Provide MaxCell fabric type inner duct with cable pulling tape in all cells. Each inner duct shall provide for three cable placements (cells). Three inner ducts shall be installed per duct in conduit being utilized.
3. Install pull rope in vacant conduits.
4. Push inner duct and pull ropes back into the end of spare conduit runs and install cap to prevent mud and water from entering conduit.

F. Manholes.
1. Manholes installed in roadway or in locations subject to vehicular traffic shall be designed by a structural engineer for H20 loading per AASHTO.
2. Manholes that are higher in elevation than the facility's main telecommunication room shall have sump pumps installed to prevent accumulated water from draining into the main telecommunication room.
3. A high sump level alarm shall be provided to the facility's building automation system.

3.7 TELEPHONES

A. All telephones will be provided by the Company.

3.8 NETWORKING EQUIPMENT

A. The Company will furnish and install all network equipment. If required, the seller shall provide ample rack space for POTS, LAN, VOIP, PA, and fire alarm equipment.

B. The seller shall coordinate with the Company in regard to equipment layout in the racks.

3.9 WIRELESS NETWORKING EQUIPMENT

A. No new wireless access points are anticipated.

3.10 PUBLIC ADDRESS SYSTEM

A. Service for the ORNL PA system is provided via ORNL network connection.

B. The Seller shall extend the existing PA system using class connection components by Valcom and Valcom Services LLC.

C. The PA coverage shall be provided for all corridors, stairwells, restrooms, locker rooms, shop areas, open office areas, break rooms, and other areas where multiple occupancy is expected.

D. The Seller to submit system shop drawings developed by the vendor or distributor established as a PA system designer.

E. The PA systems typically consist of the following components:
1. Networked Station Port Model VE8011.

2. Networked Trunk Port Model VE8021.
3. Networked Page Zone Extender Model VE8001.
4. 24 VDC, 6A power supplies.
5. 15 and 5 Watt Horn, self-amplified.
6. Flush mount 8” ceiling speaker, self-amplified.
7. Surface-Mount speakers, self-amplified.
8. 2’x2’ drop in ceiling speaker, Model VIP-402A.
9. Provide components necessary to provide local paging for two zones (floors).
10. Speaker cable shall be Category 5 (minimum), orange jacket. Route speaker cables in telecommunication cable trays where available or provide other suitable means to support cable in non-exposed areas. Provide conduit or other suitable raceway in non-finished areas.
11. The number of speakers required for adequate coverage of an area shall be based upon a comfortable listening level of paging for personnel in close proximity to speakers. Speakers shall typically be spaced at 25’ in interior finished areas such as open offices and corridors.
12. Exterior horn speakers shall be provided; a minimum of four 15 watt (W) units.

3.11 FIRE ALARM SYSTEM.

A. See Fire Protection section for specific seller-provided requirements to support network connection of the fire alarm system. The Seller shall provide all fire alarm network electronics, fiber optic and Category 6A interconnections to the fire alarm system.

3.12 BUILDING AUTOMATION SYSTEM

A. New equipment shall be connected to the existing building automation system (BAS). The system to be used shall be Metasys Direct Digital Control (DDC) supplied by Johnson Controls. The BAS connects to the ORNL site BAS with a dedicated network switch served from the outside service fiber.

3.13 CENTRAL ENERGY DATA SYSTEM (CEDS)

A. No additions to the facility CEDS are anticipated.

3.14 TELECOMMUNICATIONS EQUIPMENT COOLING

A. Adequate cooling shall be provided in new telecommunication rooms to offset heat generated by networking and other telecommunication equipment. See HVAC section for requirements.

3.15 SPECIFICATIONS

A. Specifications shall indicate the following requirements.
1. Qualifications

a. Installation shall be under the direct supervision of a Building Industry Consulting Service International, Inc. (BICSI) Registered Level 2 Installer (copper and/or optical fiber as applicable) who shall be present at all times when work is performed.
b. Testing shall be under the direct supervision of a BICSI Registered Technician, who shall be present at all times when testing is being performed.
c. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings, and field testing program development by a BICSI Registered Communications Distribution Designer (RCDD) or Registered Outside Plant Designer (OSP) as applicable to the type of project.

2. Optical fiber installation procedure.
   a. Optical Fiber shall be installed and terminated by BICSI certified personnel.
   b. Optical Fiber shall be tested and certified by using an Optical Loss Test Set (OLTS) certification kit.
   c. After testing is complete, a BICSI formatted acceptance test report shall be generated and submitted to the company for audit and approval.

END OF SECTION 01 86 27

SECTION 01 86 28– ELECTRONIC SAFETY AND SECURITY

PART 1 - PROJECT REQUIREMENTS

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

PART 2 - CODES AND STANDARDS

2.1 DESIGN STANDARDS

A. Work Smart Standards referenced in Section 01 41 00 apply to this Section.

B. Engineering Standards
   1. Not applicable.

PART 3 - TECHNICAL REQUIREMENTS

3.1 GENERAL SECURITY AND ACCESS CONTROL REQUIREMENTS

A. The Seller to provide the following:
   1. All conduit, back boxes, and wiring necessary for connections between access control, intrusion detection, and camera devices to panels or network switches.
   2. AC power for controllers and power supplies.
   3. Telecommunication service wiring (fiber and copper) to new communication rooms.
   4. Door hardware such as electric door strikes, electric door latches, automated door openers, and required power supplies.

B. Government furnished equipment (GFE).
   1. The government furnished equipment shall include access control system (ACS) and intrusion detection system (IDS) controllers (enclosures and panels), badge readers, detection devices, cameras, and network devices.

C. Building access control shall be provided as follows:
   1. The entire building perimeter shall be controlled by Company supplied access control panel(s) connected to ORNL's Site ACS. All perimeter entrances shall be provided with badge readers.
   2. Telecommunication rooms, mechanical rooms, electrical rooms and other rooms indicated in the room data sheets shall be provided with badge readers similar to perimeter entrances.

3. Electric door strikes and latches shall be served with power supplies that include battery backup.

D. All security features and functions will comply with the requirements of the IBC and ADA and shall not create any impairment of the means of egress. Initiation of a fire alarm shall not disable electric door latches and strikes.

E. All door locksets shall be provided with Best 7-pin A series lock cores, for master keying by the Company.

3.2 CONTROLLERS FOR ACCESS CONTROL, INTRUSION DETECTION, AND VIDEO SURVEILLANCE

A. Any required new control panels/enclosures will be provided and installed by the Company. The Seller shall provide rough in and cabling from the enclosure(s) to access control, intrusion detection, and surveillance devices. A 6”x6”x6’ wireway shall be provided over the enclosures with (4) 2” conduits routed to the nearest cable tray.

B. The Seller shall supply each control panel and exterior door strike/latch power supplies with 120-volt AC emergency-backed power.

C. Badge readers.
1. Badge readers shall be installed in accordance with Americans with Disabilities Act (ADA) standards.
2. Provide one #22 gauge, shielded twisted pair, Belden 6504FE or equivalent cable from the control panel to the door.
3. Provide rough in with single-gang, metal outlet box and wiring for separate card readers that shall be supplied for electric door operators used for handicap entrance.

D. Door hardware.
1. Where crash bars are required, door hardware shall be Von Duprin EL99, electric latch.
2. Where conventional door hardware is allowed, door strikes shall be a HES Model No. 5000-24D, 501 face plate.
3. Power supplies for electric latches and strikes shall be supplied by the Seller and shall include battery backup for exterior doors.
4. Power supplies shall be located with the access control panels. Provide rough in and wiring from the power supply/controller to electric strikes and latches using one 14 gauge, 2-conductor, Belden 6100FE or equivalent cable.

E. Access control material list.

MATERIAL	Part #
Hirsch M8 ACS Panel with Power Supply, 22”x20”x 6.25” (HxWxD)	M8 (GFE)
Hirsch M2 ACS Panel with Power Supply, 18”x15.25”x5.5” (HxWxD)	M2 (GFE)
Von Duprin PS 914 Power Supply, 14"x12"x4" (HxWxD)	PS914
Von Duprin 900-4R Power Supply 4 Relay Output Board	900-4R
WxDVon Duprin 900-4R Power Supply 4 Relay Logic Board	900-4RL

Von Duprin 900-BB Battery Back-up Board	900-BB
PowerSonic 12V 7.5 AH Backup Battery	PS-1270 F1
Maxxess EP1501 Controller	EP1501 (GFE)
Maxxess MR50 Reader Board	MR50 (GFE)
PIVClass Standard Badge Reader RP40-H	920PHRNEK00005
PIVClass Standard Badge Reader RPK40-H	921PHRNEK0002H

3.3 INTRUSION DETECTION

A. General.
1. Provide rough in and wiring for intrusion detection sensors.
2. The Seller shall coordinate with ORNL Laboratory Protection Division/Security Systems Group to determine sensor layout and wiring requirements.
3. Assume each motion sensor will require one 6 conductor, #22 gauge, Belden 6504FE or equivalent cable.
4. Assume each door switch (BMS), duress switch, or indicator light will require one #22 gauge, Belden 8761 or equivalent cable.
5. All cables shall be installed in metal conduit between the end device and the controller. If cable for these circuits must be run exposed, it shall be routed in the area within the security zone.

B. Intrusion detection material list.

MATERIAL	Part #
Hirsch M16 IDS Panel	M16N (GFE)
Motion Power Supply, Altronix 12VDC	AL600USACMCB (GFE)
PowerSonic 12V 7.5 AH Backup Battery	PS-1270 F1 (GFE)
Magnasphere Balanced Magnetic Switch	SBMS3-L2HSS (GFE)
Bosch Motion Detector, 360 degree	Bosch 9360 (GFE)
BlackBox Fiber Converter	LIC023A-R2 (GFE)
GE/Sentrol Duress switch	3045-W (GFE)
Hirsch Alarm Access Keypad	DS47L-HI (GFE)
Hirsch Access Keypad Mounting Box	MB1 (GFE)
Indicator Light	(GFE)

3.4 VIDEO SURVEILLANCE

A. General.
1. Provide rough in and CAT 6 ethernet wiring for video surveillance equipment.
2. The Seller shall coordinate with ORNL Laboratory Protection Division/Security Systems Group to determine camera layout and wiring requirements. Cameras will be power-over-ethernet devices.

3.5 DRAWINGS AND SHOP DRAWINGS

A. Drawings shall include conduit plans, details, and legends. Typical elevation details shall be provided for each type of installation.

END OF SECTION 01 86 28

SECTION 01 89 00 – SITE IMPROVEMENTS

PART 1 - PROJECT REQUIREMENTS

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. General
  1. Provide walkways into the new facility
  2. Provide space for fire apparatus to access the facility.

PART 2 - CODES AND STANDARDS

2.1 DESIGN STANDARDS

A. Work Smart Standards referenced in Section 01 41 00 apply to this Section.

B. Additional standards/guides.
  1. Department of Agriculture’s Soil Conservation Service Technical Report TR55, Urban Hydrology for Small Watersheds.
  2. American Society of Civil Engineers (ASCE), Manual of Standard Practice ASCE 77 - Design and Construction of Urban Storm Water Management Systems.
  3. Tennessee Department of Environment & Conservation (TDEC) Erosion and Sediment Control Handbook.
  4. Tennessee Department of Transportation (TDOT), Standard Specification for Road and Bridge Construction.
  5. Tennessee Department of Transportation (TDOT), Drainage Manual.
  6. DOE STD 1020 – 2002, Natural Phenomena Hazards and Evaluation Criteria for DOE Facilities.
  7. American Society of Civil Engineers (ASCE), Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data, CI/ASCE 38-02.

PART 3 - TECHNICAL REQUIREMENTS

3.1 SITEWORK

A. Earthwork and Grading Plan facilities: to fit the topography with a minimum of grading, and to preserve the site character in an efficient and economical manner. Follow all applicable recommendations in the project geotechnical report.

1. Final grading design shall minimize the need for site retaining walls to the greatest extent possible.
2. Design the site grading in such a way as to balance the earthwork cut and fill quantities.
3. To prevent surface drainage from entering or ponding adjacent to the structure, place finished floor elevations sufficiently above the existing ground gradient or the roadway grade, and slope the outside grade away from the building. A minimum slope of 5 percent shall be provided within a 10-foot distance of the building.
4. Erosion control measures shall be detailed on the design drawings and shall be in accordance with the TDEC Erosion and Sediment Control Handbook.
   a.
5. Eliminate/minimize construction activities which will require permits (i.e., TDEC's ARAP permit, etc.).
6. Maximum finish graded slopes shall be 1:3, unless positive erosion protection is provided, such as rip rap.
7. Coordinate the location of the building with surrounding structures to meet all codes and fire department setback issues.
8. Permanent seeding will be required on all disturbed areas. Seed mixture shall be as required by the Company.

B. Security fencing.
1. Permanent security fencing shall consist of a minimum of 9-gage, galvanized chain link steel fabric with mesh openings not larger than 2 inches. Three strands of barbed wire on outriggers shall top fencing.
2. Overall fence height shall be a minimum 8 feet including the outriggers.
3. Posts, bracing and other structural members shall be located on the inside of secured perimeters.
4. Once in place, all fence hardware shall be peened or spot-welded to prevent easy removal.
5. A minimum clear zone of 20 feet shall be provided along each side of security fence perimeters.
6. Fence grounding shall be in accordance with Section 01 86 26, Electrical.
7. All-weather patrol roads or walkways shall be provided along the inside of the perimeter security fence surrounding security areas in cases where the security fence will be patrolled by a security force.
8. Standard security fencing is installed over paved surfaces with the bottom rail as close to the pavement as possible.
9. Use swinging gates in fencing where possible. When rolling gates are required, use a system with an overhead support, if practical. If a cantilevered gate must be used, use a system with an enclosed top rail as a track. Avoid using rollers at grade.
10. Tension wires shall be installed along the top and bottom edges of the fence fabric. Rails may be considered for installation in lieu of tension wires.
11. Motorized gates shall be considered for primary access points. Motorized gate controls shall, where practicable, be located within guard stations of each access point. Motorized gates shall be designed to facilitate manual operation during power outages.

3.2 SIDEWALKS

A. Contraction and expansion joints shall be provided and shown on the drawings.

B. Walks shall comply with ADA/UFAS and have a medium to heavy broom finish for slip resistance.

C. Concrete mix shall be 4000 psi minimum with 5%-7% air entrainment to minimize damage due to freeze-thaw cycles/ice melt chemicals. Testing only required for air entrainment not strength.

D. Base the width of sidewalks on anticipated traffic, with a minimum width of 4 feet.

E. Sidewalks construction shall be 4 inches thick minimum over a 3 inch base of #57 stone. Also, sidewalks shall be reinforced with welded wire fabric.

3.3 ROADS AND PARKING

A. Design and details for construction of flexible and rigid pavements shall comply with Tennessee Department of Transportation (TDOT), Standard Specification for Road and Bridge Construction, and any recommendations made in the site geotechnical report.

B. Provide adequate access to existing traffic patterns.

C. Design of parking areas shall include 9-foot-wide spaces with 90-degree parking being preferred. All striping shall be 4” wide, white in color except blue for handicapped. Thermoplastic type paint shall not be utilized for marking pedestrian crosswalks.

D. Parking area circulation must allow for all types of traffic that may be associated with the facility, including deliveries, emergencies and garbage pick-up.

E. Clearly indicate turning radii requirements on parking area entrances and islands. If access for fire, maintenance and trash service vehicles is required for the facility and routing through the parking area is necessary, provide layout with turning radii in accordance with the latest edition of the AASHTO publication, A Policy on Geometric Design of Highways and Streets for the appropriate design vehicle type.

F. Geometric design and gradients of all roads, streets, access drives and parking areas shall comply with AASHTO - A Policy on Geometric Design of Highways and Streets (GDHS).

G. Design of bridges shall comply with AASHTO LRFD Bridge Design Specifications, US Units, 4th Edition, 2008 Interim Revisions.

H. Road and street grade changes in excess of 1% shall be accomplished by means of vertical curves; the length of vertical curves shall be determined in accordance with AASHTO - GDHS.

I. Roadway centerline gradient profiles shall be shown for vertical control.

J. Positive drainage shall be provided for parking area pavement. Slopes shall be 1% min/4% max.

K. Handicap parking allocations shall comply with ADA/UFAS.

L. Concrete curbs and gutters shall be provided for all parking areas.

M. Parking stops shall be manufactured from concrete with a minimum of 20% fly ash and shall be anchored to the pavement with rebar. Parking stops shall be provided adjacent to sidewalks without curb, buildings, fences, in areas where part of a vehicle extending past the striped space would likely cause property damage and in areas of extreme slope or areas adjacent to storm water management facilities. Locate the front face of the parking stop 30 inches from the edge of the pavement or sidewalk.

N. Bollards must be 4 feet high, 4-inch diameter steel pipe filled with concrete and painted. Provide bollards around any structure subject to damage from vehicular damage by incidental contact. Ensure that an adequate concrete foundation is designed for the bollard.

O. Traffic control devices shall be in accordance with AASHTO - MUTCD. Provide signs, and associated pavement markings to facilitate proper utilization of the project site.

P. When dumpsters are required, provide a dumpster pad with an enclosure. Provide a concrete pavement pad to support and accommodate the dumpsters and front wheels of the service truck.

Q. Flexible pavements shall be used for roadways, access drives, and parking areas. Rigid pavements shall be used for dumpster pads, loading dock aprons, and other pavement areas subjected to high stresses.

R. Pavement systems shall include provisions for under-pavement drainage, if required by the site geotechnical report.

3.4 DESIGN DRAWING INFORMATION

A. Design drawings shall use the ORNL grid system. A minimum of two survey control points with their coordinate values and elevations shall be shown on the project site drawings.

B. Provide ORNL north arrows and graphic scales on all applicable drawings.

C. Demolition plans shall clearly show what is to be demolished at an appropriate scale and shall indicate the beginning and ending points of utility removals and methods of plugging pipes. Show locations of valves for isolating work. Describe existing items to be removed in detail with supplemental descriptions if necessary. Indicate depth of pavements/bases to allow uniform seller bids. Provide a demolition sequence if necessary and include any known requirement for continuous operation and limited shutdown requirements. Do not show any items that are being demolished with the current project on subsequent Civil plan sheets. Provide an appropriate tree protection detail for existing trees which are to be preserved during construction.

D. Site plans shall show all new above ground features with adequate layout data and existing aboveground features after demolition has occurred. Show areas requiring pavement patching, repairs and new pavement. Provide pavement jointing plans for rigid pavement. Eliminate extraneous items which may congest the drawing and detract from the layout information. Show locations of any additional erosion and sedimentation control items not already identified on the demolition plan. Indicate all trees and plant material to remain.

E. Utility plan sheets shall provide profiles where needed for clarity and to avoid potential conflicts. Indicate structure tops, pipe invert elevations, slopes, lengths and diameters of all new gravity lines. Reference the plan sheets where pipes/structures are shown. Show and label existing and new surface materials, concrete pads, curbs, roads, etc. traversed by the new lines. Accurately show the depths of existing pavements. Show and label all crossing utility lines, both existing and new. Indicate the method of new utility installation routing above or below conflicts, i.e. concrete encasement, pressure pipe, etc.

F. Grading plans shall provide spot elevations and existing contours at intervals to clearly indicate existing drainage patterns. Provide spot elevations and new contours when appropriate to clearly indicate new grading and drainage patterns. New spot elevations/contours must be easily distinguished (bolder font) from existing. Indicate where new grade ties to existing grading (limits) and verify that new work will not block existing adjacent drainage. Show all benchmarks, other vertical control and datum notes on this plan. Show finished floor elevations on the grading plans. Coordinate with the Landscaping Plans to prevent new plantings from blocking site drainage. Provide numbers (or letters) for each drainage structure so that plans, and profiles are easily coordinated. Erosion and sediment control details should be shown.

G. Details of items shown in TDOT's construction standards or other appropriate local/commercial standards are required to be included on the plan sheets.

H. An electronic copy of the Civil calculations (pdf file format) shall be provided to the Company by the Seller. The calculations shall be sealed by a Professional Engineer licensed in Tennessee for record purposes.

END OF SECTION 01 89 00

SECTION 01 89 00.2 FIRE APPARATUS ACCESS

PART 1 - PROJECT REQUIREMENTS

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

PART 2 - NOT USED

PART 3 - TECHNICAL REQUIREMENTS

3.1 General

A. Maintain all fire lanes all buildings with at least 20 ft of unobstructed width and a minimum vertical clearance of 13 ft 6 in.

B. Fire lanes shall be clearly identified with either signs or painted markings with the words "Fire Lane No Parking."

C. Provide at least 3 ft clear space in front of fire hydrant outlets and fire department connections to sprinkler or standpipe system.

3.2 FIRE APPARATUS ACCESS

A. Fire Apparatus Access Road Distance From Building And Turnarounds
   1. Access roads shall be within 150 feet of all portions of first story exterior walls of the building, as measured by an approved route around the exterior of the building. When buildings are protected throughout with an approved automatic sprinkler system that is installed in accordance with NFPA 13, thedistance shall be permitted to be increased to 450 ft.

B. Fire Apparatus Access Road Exception For Automatic Sprinkler Protection:
   1. When buildings are completely protected with an approved automatic fire sprinkler system, the requirements for fire apparatus access may be modified as approved by the ORNL AHJ.

C. Fire Apparatus Access Road Width And Vertical Clearance:
   1. Fire apparatus access roads shall have an unobstructed width not less than 20 feet and an unobstructed vertical clearance not less than 13 feet 6 inches.

3.3 Bridges:

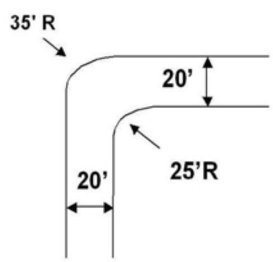
A. Private bridges shall be designed and constructed to support a gross vehicle weight of not less than 50,000 pounds. Commercial bridges shall be designed and constructed to support gross vehicle weight of not less than 75,000 pounds. Weight signs shall be posted at both entrances of the bridge.

3.4 Roadways:

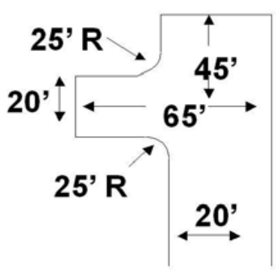
A. Fire apparatus access roadway grades shall not exceed an average grade of 10% with a maximum grade of 15% for lengths of no more than 100 feet. Intersections and turnarounds shall be level with the exception of crowning for water run-off.

B. Surface And Load Capacities:
   1. Fire apparatus access roads shall be of all-weather surface that is easily distinguishable from the surrounding area and is capable of supporting at least 50,000 pounds live load (gross vehicle weight). Commercial access roads shall be capable of supporting at least 75,000 pounds.

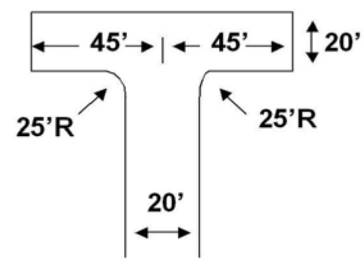
C. Turning Radius:
   1. The inside turning radius and outside turning radius shall be not less than 25 feet and 45 feet respectively, measured on the same center point.
   2. Turning Radius



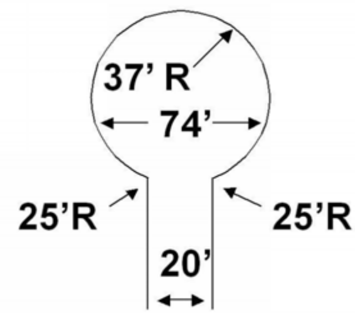
D. Dead End Roads:
   1. Dead end fire apparatus access roads in excess of 150 feet in length may be required to have an approved turnaround. See below for approved turnaround diagrams.
      a. Hammer Head Alternate Turnaround



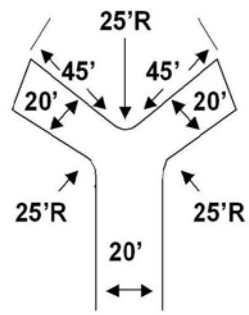
b. Hammer Head Turnaround



c. Cul-De-Sac Turnaround



d. "Y" Turnaround



E. No Parking Signs:

1. Where fire apparatus roadways are not a sufficient width to accommodate parked vehicles *and* 20 feet of unobstructed driving surface, "No Parking" signs or curb markings shall be installed on one or both sides of the roadway and in turnarounds as needed.
   a. Signs shall read "No Parking-Fire Lane-Tow Away Zone" and shall be installed with a clear space above the ground level of 7 feet. Signs shall be 12 inches wide by 18 inches high and shall have black or red letters and border on a white background. See the diagram below.

1) NO PARKING SIGN

b. Painted Curbs:

1) Fire apparatus access roadway curbs shall be painted red and marked "No Parking Fire Lane" every 25 feet. Lettering shall have a stroke of not less than one inch wide by six inches high.

END OF SECTION 01 89 00.2

SECTION 01 89 19 – SITE PLUMBING UTILITIES

PART 1 - PROJECT REQUIREMENTS

1.1 SUMMARY OF SITE PLUMBING UTILITIES

A. General
1. Tie-ins to existing utilities will be accomplished by the Company. The Contractor shall provide materials, excavation, and site restoration.
2. Existing utilities located under the new construction or within ten feet of the proposed facility shall be rerouted by the Seller per this document and TDEC rules and regulations.
3. Fire hydrants shall be provided in sufficient quantity and location to satisfy the Company.
4. Provide new looped potable water pipe to the southeast by connecting the piping at building 4515 and building 3608.
5. If the requirements listed in this section conflict with other sections, the most stringent requirements shall be provided.

B. Required Calculations
1. Pipe sizing calculations.
2. Storm water and flooding calculations per TDOT.

PART 2 - CODES AND STANDARDS

2.1 DESIGN STANDARDS

A. Work Smart Standards referenced in Section 01 41 00 apply to this Section.

B. Additional Standards/Guides.
1. Guiding Principles for Sustainable Federal Buildings
2. Underwriters Laboratories (UL).
3. Factory Mutual (FM).
4. Foundation for Cross-Connection Control and Hydraulic Research.
5. AWWA M41, Manual of Water Supply Practices, Ductile Iron Pipe and Fittings.

C. Engineering Standards
1. ES-MECH-G-01 Mechanical Systems 851 Codes

PART 3 - TECHNICAL REQUIREMENTS

3.1 GENERAL

A. Code/ Design
1. All systems shall be designed to codes outlined in Engineering Standard ES-MECH-G-01, Mechanical Systems 851 Codes.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Piping systems shall be tested per the hydrostatic testing requirements of listed code reference based upon the design pressure.
4. If new building or other permanent structures are to be built above existing underground mechanical utilities, the underground utilities shall be relocated.
5. Locate new utilities so as to minimize connection costs. Underground utilities shall not be routed under buildings or other permanent structures.
6. When flowable fill is required for trench backfill or other applications, it shall meet the minimum recycled content per the EPA's Comprehensive Procurement Guidelines.
7. Provide coordinate locations for all underground utilities, indicating horizontal and vertical locations of connection points, abrupt changes in direction and system components, as well as enough locations along the lines to clearly establish their location.
8. Refer to the Atlas Utility Drawings for the best-known underground utility information. This information is provided for information only. The AE/Seller is required to verify as-built conditions.
9. Provide valving necessary for installation and operation of each piping system. Design shall consider safety, system operation, installation outages required, interface with new and existing portions of the system, reliability and maintainability at a minimum.

B. Metering and Data Collection
1. The Energy Management and Control System shall monitor the domestic and process water, chilled water, and compressed air.
2. A single Modbus-to-Ethernet gateway may be used to support all devices and an RS-485 multidrop network configuration may be used between devices.

C. Reliability/Maintainability
1. Sustainability – The piping systems shall be sustainable.
2. Reliability- Systems for critical applications shall be designed with sufficient backup so that the failure of any one component does not preclude operation of the system.
3. Equipment arrangements shall allow for all maintenance access requirements, component removal space, lay down areas and any other clearances and platforms for safe operation, maintenance, replacement, and repair of all equipment.
4. Flexibility- the piping systems shall be sized to meet their intended load, plus 10% spare capacity unless otherwise specified.

D. Materials
1. All materials/equipment shall bear the Underwriter's Laboratories (UL) label or be approved by Factory Mutual (FM) where UL labels or FM approval is available for the type of products specified or other Nationally Recognized Testing Laboratory (NRTL).
2. Buried piping.
   a. Indicator tape shall be laid 18" above buried piping.
   b. Tracer wire shall be laid continuously along the top of all buried piping.

c. Attach the wire at five-foot intervals to the pipeline with several wraps of tape.
d. Tracer wire shall run up and down exterior side of valve boxes, looped but not cut, into the valve box just below the cover.
e. Splices shall be avoided. Splices and wire ends shall be waterproofed.
f. Verify electrical continuity by applying an electrical current.
g. Wire Spec: 14 AWG conductor, solid white, TWH solid copper with plastic coat. Splice connectors: Burndy KS-90 16-10 wrapped with insulating mastic tape.
h. The ends of the tracer wire shall terminate inside a valve or junction box. A minimum of twelve inches of wire shall be located within the box.

3. Unacceptable materials include:
   a. Acrylonitrile butadiene styrene (ABS) plastic pipe.
   b. Material or components containing asbestos, polychlorinated biphenyl (PCB), CFCs, lead, and carcinogens shall not be utilized.
   c. Utilities shall be free from hazardous materials according to applicable federal, state, and local environmental regulations.
   d. Zinc chromate paint
   e. Class I Refrigerants

E. Construction
1. Packaged system shall be installed on site by manufacturer or manufacturer's representative. Contractor to coordinate locations of plumbing and electrical utility connections and makes provisions for final connections.

F. Start-up
1. Packaged systems shall be commissioned with the manufacturer’s representative onsite.
2. Site training shall be provided per Section 01 79 00.

3.2 UTILITIES

A. Potable Water and Firewater Piping
1. Code/Design
   a. The ORNL water supply system is a combined potable water and fire service main.
   b. Water mains shall be designed with a minimum 36” of cover.
   c. Design for normal operating pressure range of 40 - 100 psi.
   d. Test pressure 200 psi.
   e. Restraint systems shall be designed per AWWA M41, Manual of Water Supply Practices, Ductile Iron Pipe and Fittings. Restraint systems may consist of concrete thrust blocks, EBBA Megalugs, and/or US Pipe Field Lok gaskets. Pipe restraint locations and details shall be shown on the drawings.
   f. The building water supply and fire protection system water supply shall have separate piping feeding the building. The building water supply shall be isolatable without affecting the fire protection systems.
   g. Water mains should maintain the following distances from building foundations: 8” diameter or less - ten feet clearance, greater than 8” diameter - twenty feet clearance.
   h. Water piping shall be separated from other pipelines carrying non-potable or other hazardous materials in accordance with the Potable Water Distribution System Description Document, UT-MECH_ADM_002.

i. SCADA information shall be transmitted to the Utilities Division Control Room in Building 2519 through the Energy Management and Control System.
j. See Section 01 86 16 for backflow prevention.
k. Potable water system modifications other than service connections will be submitted to TDEC by the Company. The Seller is responsible to provide all documents required by TDEC, address TDEC comments and provide resolution.

2. Materials
a. Coatings or linings for distribution system components that come into contact with potable water shall meet AWWA Standards, NSF/ANSI 61, or other appropriate standard.
b. Site Standards:
1) Pipe: Ductile Iron
2) Valves: Gate: Mueller 2360. Resilient Wedge Gate Valves with PIV Plate, counterclockwise to open
3) Fire Hydrant: Muller Super Centurion, 250 A-423, , counter clockwise to open
4) Post Indicators: Mueller A20806
5) Motor Actuators: Limitorque L120

3. Construction
a. Submit water quality reports for all modifications to the potable water distribution system.
b. Disinfection of new or repaired pipes shall be in accordance with ANSI/AWWA C651.
c. Submit disinfection plan to Company for approval, including chlorination, hold times, and bacteriological analysis.

B. Storm Water Management System.

1. Code/Design
a. Meet statutory requirements for new construction, modernizations, and renovations, and employ strategies that reduce stormwater runoff and discharges of polluted water offsite to protect the natural hydrology and watershed health. Where feasible, use low impact development (LID) strategies to maintain or restore the natural. Pre-developed ability of a site to manage rainfall.
b. The Storm Water Management System shall be designed for not less than the 25-year, 24-hour storm. The existing storm drain system shall be analyzed to ensure adequate capacity for any new connections to the system as well as the effects that any additional runoff resulting from the new construction will have on the receiving water's downstream facilities. In lieu of the TR-55 Method, the Rational Method of analysis may be used to determine storm water runoff quantities for sizing and/or analyzing the storm water drainage system provided that the drainage area under investigation is no larger than 5 acres, and that the method is not used for the design of storage facilities. No new discharge points to receiving waters will be allowed.
c. The total area to be drained shall be considered when analyzing and sizing the storm water system. All runoff shall be controlled and tied to the storm water system, as appropriate.
d. Hydraulic design of storm drainage systems shall comply with American Society of Civil Engineers' (ASCE), Manual of Standard Practice ASCE 77 - Design and Construction of Urban Storm Water Management Systems. The minimum storm

drainpipe diameter shall be 12 inches. The minimum culvert diameter shall be 15 inches. For roof drains, the minimum pipe diameter for laterals and collectors shall be 4 inches.

e. Provide straight alignments for piping between storm drainage structures with deflection at structures no greater than 90 degrees for main line flow (24" diameter and greater) and 120 degrees for contributory flow lines. Use of curvilinear alignment is not allowed.

f. Provide inlets on roads to reduce spread in accordance with the Tennessee Department of Transportation's (TDOT) Drainage Manual. The spread shall never be more than ½ of a driving lane based on a 5-year storm intensity.

g. In the design of culverts and storm drains, consider headwater and tailwater and their effects on hydraulic grade line and capacity. The hydraulic grade line for the drainage system shall not exceed an elevation one foot above the pipe crown, or one foot below the structure rim or gutter flow line at inlets, whichever is the lower elevation at each structure. Culverts shall not be surcharged more than one foot at either end. At structures, the inlet pipe crown elevation must be equal to or greater than the outlet pipe crown elevation to minimize hydraulic turbulence at the junction. Provide adequate slope in the structure's flow channel to accommodate the hydraulic losses through the structure.

h. The pipe size must not decrease downstream in the direction of the flow. This shall include connections of new collection systems to existing facilities.

i. Provide a minimum flow velocity of 2.5 feet per second and a maximum velocity of 10 feet per second using the Manning equation with the pipe flowing full and under no surcharge at peak flow conditions.

j. Locate drainage structures out of paved areas whenever possible. Adjust structure locations to avoid primary wheel tracks when structures must be located in roadways. All drainage structures shall be specified to be in accordance with TDOT's Standard Specifications for Road and Bridge Construction.

k. The storm drainage system shall not be used for discharging of process or sanitary related waste.

l. Headwalls or flared end sections shall be provided at the ends of permanent culverts and at storm drain outfalls. Protection from erosion and scouring at headwalls and flared end section outfalls shall be provided as needed.

m. Limit maximum velocities and gradients on open channels to prevent erosion on soil type and lining in accordance with the TDOT Drainage Manual.

n. Any storm drain flows which are expected to contain suspended oils shall be routed through an appropriately sized oil/water separator prior to discharge to any outfalls.

o. All roof drains shall be tied into the storm drain system. Any deviation shall be approved by the Company.

p. Where roof drainage is approved to discharged to grade, provide splash blocks/channels to direct the flow away from the structure. Eliminate safety hazards from ice, ponding, flooding etc. in pedestrian and vehicular traffic areas.

q. Storm drainage piping must be a parallel distance of at least 10 feet from building foundations for all diameter pipes.

2. Materials
   a. New material shall be:
      1) Reinforced concrete pipe (RCP) in accordance with ASTM C76/AASHTO M170, Class III, Wall B, with bell and spigot joints and gaskets per ASTM C443. RCP shall be used under all roadways.
      2) High Density Polyethylene (HDPE), corrugated with smooth inner wall per AASHTO M-294, and rubber gasket joints per ASTM D3212.
      3) Corrugated Metal Pipe (CMP), AASHTO M36.
      4) Poly Vinyl Chloride (PVC), ANSI/ASTM D3034, Type PSM, Use PVC for storm drains 10 in. and smaller.
      5) SR 35 pipe is unacceptable

3.3 DESIGN DRAWING INFORMATION

A. Design drawings shall use the ORNL grid system. A minimum of two survey control points with their coordinate values and elevations shall be shown on the project site drawings.

B. Provide ORNL north arrows and graphic scales on all applicable drawings.

C. Demolition
   1. Plans shall clearly show what is to be demolished at an appropriate scale and shall indicate the beginning and ending points of utility removals and methods of plugging pipes.
   2. Show locations of valves for isolating work.
   3. Describe existing items to be removed in detail with supplemental descriptions if necessary.
   4. Provide a demolition sequence if necessary and include any known requirement for continuous operation and limited shutdown requirements.
   5. Do not show any items that are being demolished with the current project on subsequent Civil plan sheets.
   6. Provide an appropriate tree protection detail for existing trees which are to be preserved during construction.

D. Site plans:
   1. Show all new above ground features with adequate layout data and existing aboveground features after demolition has occurred.
   2. Show areas requiring pavement patching, repairs and new pavement.
   3. Provide pavement jointing plans for rigid pavement.
   4. Eliminate extraneous items which may congest the drawing and detract from the layout information.
   5. Show locations of any additional erosion and sedimentation control items not already identified on the demolition plan. Erosion prevention and sedimentation control (EPSC) items may also be shown on separate EPSC plan sheets.
   6. Indicate all trees and plant material to remain.

E. Utility plan sheets
   1. Shall provide profiles for gravity sewers 8 inches and larger and where needed for clarity to avoid potential conflicts.

2. Indicate structure tops, pipe invert elevations, slopes, lengths and diameters of all new gravity lines.
3. Reference the plan sheets where pipes/structures are shown.
4. Show and label existing and new surface materials, concrete pads, curbs, roads, etc. traversed by the new lines.
5. Accurately show the depths of existing pavements.
6. Show and label all crossing utility lines, both existing and new.
7. Indicate the method of new utility installation routing above or below conflicts, i.e., concrete encasement, pressure pipe, etc.

F. An electronic copy of the Civil calculations (pdf file format) shall be provided to the Company by the Seller. The calculations shall be sealed by a Professional Engineer licensed in Tennessee for record purposes.

END OF SECTION 01 89 19

SECTION 01 89 23 – SITE HVAC UTILITIES

PART 1 - PROJECT REQUIREMENTS

1.1 SUMMARY

A. Where conflicts arise between this section and the CDR, this section takes precedence.

PART 2 - CODES AND STANDARDS

2.1 DESIGN STANDARDS

A. Work Smart Standards referenced in Section 01 41 00 apply to this Section.

B. Engineering Standards
   1. ES-MECH-G-01 Mechanical Systems 851 Codes

PART 3 - TECHNICAL REQUIREMENTS

3.1 GENERAL

A. Code/Design
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Sustainability – The piping systems shall be sustainable.
   3. Reliability- Systems for critical applications shall be designed with sufficient backup so that the failure of any one component does not preclude operation of the system.
   4. Maintainability
      a. Equipment arrangements shall allow for all maintenance access requirements, component removal space, lay down areas and any other clearances and platforms for safe operation, maintenance, replacement, and repair of all equipment.
      b. Maintainability designs shall minimize disruption of building functions. Every effort will be made to design, layout and install equipment in locations, which will tend to encourage routine preventive maintenance by providing easy access for maintenance personnel.
   5. Piping systems shall be tested per the hydrostatic testing requirements of listed code reference based upon the design pressure.
   6. Flexibility- the piping systems shall be sized to meet their intended load, plus 10% spare capacity unless otherwise specified.

7. If new building or other permanent structures are to be built above existing underground mechanical utilities, the underground utilities shall be relocated.
8. Supports/Hangers
    a. Piping systems, components and equipment shall be designed and anchored in accordance with Section 01 82 00, Structural.
    b. Support spacing shall not exceed spans given per ASME B31 Code series.
    c. Pipe hangers and supports shall not penetrate the insulation on chilled water lines.
9. Corrosion Protection
    a. Protect piping against corrosion either by natural resistance of the material or by other protective measures, see Section 01 86 26, Electrical for cathodic protection.
10. Provide valving necessary for installation and operation of each piping system. Design shall consider safety, system operation, installation outages required, interface with new and existing portions of the system, reliability and maintainability at a minimum.
11. The Building Automation System, BAS, shall monitor gas meter, and other requirements of this section. Additional requirements of the BAS are included in Section 01 86 19, HVAC.

B. Materials
1. All materials/equipment shall bear the Underwriter's Laboratories (UL) label or be approved by Factory Mutual (FM) where UL labels or FM approval is available for the type of products specified or other Nationally Recognized Testing Laboratory (NRTL).
2. Unacceptable materials include:
    a. Acrylonitrile butadiene styrene (ABS) plastic pipe.
    b. Material or components containing asbestos, polychlorinated biphenyl (PCB), CFCs, lead, and carcinogens shall not be utilized.
    c. Space shall be free from hazardous materials according to applicable federal, state, and local environmental regulations.
    d. Zinc chromate paint
    e. Class I Refrigerants
3. Relief valves
    a. Shall be easily removed from the piping systems by means of flanges, threaded couplings, or other method.
    b. Shall be ASME certified.
    c. Pressure Relief Valves will be tested by Company before placing into service. Manufacturer's Pressure test for the subject relief valve shall be submitted to the Company for approval.
    d. Pressure Relief Valves will be tagged and recorded by Company for periodic testing. Periodic inspections will be performed by the Authority Having Jurisdiction.
4. Buried piping.
    a. Indicator tape shall be laid 18" above buried piping.
    b. Tracer wire shall be laid continuously along to top of all buried piping.
    c. Attached the wire at five foot intervals to the pipeline with several wraps of tape.
    d. Tracer wire shall run up and down exterior side of valve boxes, looped but not cut, into the valve box just below the cover.
    e. Splices shall be avoided. Splices and wire ends shall be waterproofed.
    f. Verify electrical continuity by applying an electrical current.

g. Wire Spec: 14 AWG conductor, solid white, TWH solid copper with plastic coat. Splice connectors: Burndy KS-90 16-10 wrapped with insulating mastic tape.
h. The ends of the tracer wire shall terminate inside a valve or junction box. A minimum of twelve inches of wire shall be located within the box.

5. Meter data shall be collected in the ION system.
6. Label all above ground pipes in accordance with ANSI A13.1.

C. Construction

1. Structural welding and acceptance criteria shall be to the applicable building and design code. Welders and weld procedures shall be qualified to the referenced American Welding Society (AWS) Structural Welding Code (AWS D1 series).
2. Welding activities associated with boilers, pressure vessel, power piping, and process piping and acceptance criteria shall be applicable to the ASME Boiler and Pressure Vessel Code (Section I, Section VIII or B31.1 and B31.3).
3. Welders and weld procedures shall be qualified to ASME Boiler and Pressure Vessel Code Section IX.
4. Equipment shall be mounted on housekeeping pads.
5. All pipe supports shall be in accordance with MSS SP-58 standard.

3.2 PIPING SYSTEMS

A. Natural Gas.

1. Code/Design
   a. Design natural gas systems to Engineering Standard ES-MECH-G-01 Mechanical Systems 851 Codes.
   b. Natural Gas Service Line is defined as the natural gas pipe downstream of the service regulator.
   c. Steel piping located below grade shall be cathodically protected.
   d. Below grade piping should be polyethelene.
   e. An industrial gas meter with local display and electronic output for connection to BAS shall be provided to all facilities, see Section below.
2. Material:
   a. Site Standard:
      1) Flow Meter: Sierra Instruments 780i-VTP (velocity, temperature, pressure) with 316 stainless steel meter body, remote display if meter is installed more than 6’ above finished floor, 120 VAC input power and Modbus RTU output for hardwired connection to ORNL’s “ICS – ION” central energy data system.
      2) Isolation valves: Boren Ballomax Premium full port ball valve, API-6D tested.
      3) Pressure Reducing Valve: Fisher
      4) Above grade natural gas piping:
         a) ASTM A106 Schedule 40, Grade B carbon steel pipe as specified in ASME B31.8. Forged fittings ASME B16.11, ASTM A105.
      5) Below Grade natural gas piping
         a) HDPE pipe and fittings conforming to ASTM D 3350 and ASTM D 2513, pipe designations HDPE PE3408/4710 PE100, rated SDR 11, MAOP 102 psig. Performance Pipe Yellowstripe® 8300 Series or

b) MDPE pipe and fittings conforming to ASTM D 3350 and ASTM D 2512, pipe designations MDPE PE 2406/2708, rated SDR 11, MAOP 80 psig. Performance Pipe DriscoPlex 6500 Series.

3. Construction
   a. Polyethylene Piping: Piping shall be joined by performance-qualified joiners using qualified procedures in accordance with AGA Manual. Manufacturer's prequalified joining procedures shall be used.
   b. Carbon steel pipe shall be welded or flanged, excluding unions.

END OF SECTION 01 89 23

SECTION 01 91 33 – COMMISSIONING

PART 1 - PROJECT REQUIREMENTS

1.1 SUMMARY

A. The Department of Energy (DOE) and other Federal agencies must meet certain requirements regarding high-performance sustainable buildings. The Guiding Principles for Sustainable Federal Buildings and Associated Instructions (Guidance) provide a means of meeting these requirements. Employment of commissioning, as defined per Section 432 of the Energy Independence and Security Act of 2007, documenting compliance with the project requirements is an essential part of the process.
   1. DOE's Federal Energy Management Program (FEMP) has made available guidance on Commissioning for Federal Facilities dated July 22, 2014.
   2. The FEMP guide provides an introduction to building commissioning, recommissioning, and continuous commissioning for federal facilities and includes case studies, best practices and cautionary tales.

B. Additional References:
   1. Federal Energy Management Program's (FEMP) – "Building Commissioning Guide"
   2. Whole Building Design Guide – see www.wbdg.org
   3. ANSI/ASHRAE/IES Standard 202, Commissioning Process for Buildings and Systems

PART 2 - NOT USED

PART 3 - TECHNICAL REQUIREMENTS

3.1 PROCUREMENT FOR SERVICES OF A BUILDING COMMISSIONING AGENT

A. The Company shall provide the statement of work to procure the services of a Building Commissioning Agent (BCA).

B. The Company will contract directly with the BCA for services.

C. The BCA will be available prior to the 30% design review.

D. The BCA will be a member of the Building Commissioning Association.

E. The BCA will prepare a commissioning plan and specification (including system verification testing and functional performance testing) that corresponds to the construction schedule and submit for Company approval.
   1. The BCA will follow the design phase and construction phase of the project and perform any re-commissioning / Warranty Expiration activities as specified.

2. The BCA will assemble and provide the Facility Systems Manual and coordinate all required operator training.

3.2 COMMISSIONING PLAN

A. The commissioning plan shall address all project requirements identified, Code requirements, and all Division 01 sections of this document, the design basis document, and the construction specifications and drawings.

B. The commissioning plan shall include system verification testing and functional integrated testing that will be performed on the following systems, as a minimum:
   1. HVAC.
      a. All air-water-refrigerant based systems for heating, cooling and refrigeration service shall be functionally tested to verify that all equipment and controls are operating as indicated in the design documentation and in accordance with manufacturer's recommendations and requirements. System operation and controls shall be verified for heating and cooling season operation, start up and shut down under normal, conditions, start up and shut down in off normal conditions, star up and shut down in emergency conditions and loss of power conditions.
   2. Plumbing.
      a. Building systems (potable water, sanitary sewer, etc).
      b. Associated site utility systems (potable water, sanitary sewer, (etc).
      c. Domestic water heaters and recirculation system.
      d. Process cooling water systems.
   3. Electrical.
      a. Building systems (power, lighting, metering, wiring devices, grounding, etc). Including DC high potential voltage tests and megohm insulation resistance measurements for medium voltage cable, low voltage cable and transformer megohm insulation resistance measurements.
      b. Emergency and standby power systems (UPSs, generators, auto-transfer switches, etc.). Perform load tests for UPSs and generators. Perform operational tests for auto-transfer switches and UPS transfer function.
      c. Associated site utility systems (power).

C. System verification testing.
   1. System verification testing shall be required to assure the component and system minimum readiness requirements have been met prior to start up and functional testing.
      a. Check equipment operation and configuration.
      b. Verify EMS calibration and operation.
      c. Verify system efficiency/performance.
      d. Testing hierarchy for system verification testing is suggested as follows.
         1) Sensor and actuator calibration.
         2) Point-to-point verification.
         3) Single control loops such as the following.
            a) VAV terminal units.
            b) Coils.
            c) Fans.

d) Other.

4) System interlocks including the following.
   a) Safety.
   b) Occupancy.
   c) Other.
5) Intersystem operation as noted in the following examples.
   a) Central plant equipment.
   b) Air handling systems.
   c) Emergency power.
   d) Other.

D. Functional performance testing.
1. Functional performance testing shall include all modes and sequences of operational control, all interlocks, conditional control responses, and all off normal and emergency operations. Sequences of control shall be verified and deficiencies noted and corrected.
2. Functional performance test procedures shall describe detailed sequential steps necessary to set control parameters and test systems and components throughout all intended ranges of operation.
3. Functional performance test procedures shall start at the basic component level operations and progress up the hierarchy of operations and system complexity. Suggested steps for functional performance test procedures are noted as follows.
   a. Record of existing settings.
   b. Sensor calibration checks.
   c. Device calibration checks.
   d. Test functions.
   e. Record Deficiencies Found.

3.3 DESIGN PHASE RESPONSIBILITIES

A. The BCA design phase responsibilities shall include the following minimum scope.
1. Review the design criteria/RFP documents prior to design commencement.
2. Review and comment design drawings, calculations, and specifications at 30/60/90/CFC submittals.
3. Review design basis established by the Company and A-E.

3.4 CONSTRUCTION PHASE RESPONSIBILITIES

A. The BCA construction phase responsibilities shall include the following minimum scope.
1. Review and comment construction submittals for compliance with the project's specifications.
2. Obtain and verify O&M Manual for equipment and systems.
3. Develop and/or track completion of construction checklists as applicable.
4. Construction documentation (record drawings) verified during site visits.
5. Commissioning team meetings held to address and resolve quality issues and roadblocks.
6. Accomplish and coordinate initial training and O&M walkthroughs.
   a. Initial Training activities may include the following and provide O&M personnel with basis to ask questions and understand contractor training.

1) First session, presented by Commissioning Authority, focuses on the Company's project requirements.
2) Subsequent sessions focus on the operational maintenance aspects of the installed equipment and fully integrated systems.

3.5 FACILITY SYSTEM MANUAL

A. The BCA shall prepare a final Facility Systems Manual (FSM) to include the following minimum documentation:
   1. The systems manual shall provide the information to operators, researchers, maintenance, and engineering personnel. Draft sections shall be submitted to the Company for approval between 30 and 60 days of shop drawing acceptance.
      a. Narrative descriptions of equipment and systems.
      b. System schematics, P&ID's, and control sequences of operation.
      c. Final O&M Documentation.
      d. Record Drawings.
      e. Initial Commissioning Report.
      f. TAB report.
      g. Training Records.
   2. The FSM shall be provided in electronic copy (pdf) and three hard copies.

3.6 WARRANTY EXPIRATION

A. The BCA shall review equipment performance prior to warranty expiration (performed by the 10-month point of 12-month warranties) to accomplish the following minimum items.
   1. Identify items that need correcting under warranty prior to expiration.
   2. Identify and remedy operational problems.

3.7 FINAL COMMISSIONING REPORT

A. The BCA shall complete and submit a Final Commissioning Report at the end of the commissioning process.
   1. One electronic copy.

END OF SECTION 01 91 33

SECTION 33 61 24 CLEANING AND FLUSHING OF CHILLED WATER, HEATING WATER, AND COOLING TOWER WATER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

A. This Section includes cleaning and flushing requirements for chilled water, heating water, and cooling tower water piping systems. It also includes initial injection of corrosion inhibitor into closed water systems.

B. The Seller shall be responsible for providing all labor, equipment, and materials required to perform piping system cleaning and flushing and injection of corrosion inhibitor, as required by the drawings and these specifications.

1.3 SUBMITTALS

A. Provide a cleaning and flushing plan describing the procedure, materials and equipment to be used and how they will be integrated into the system. Include a timeline showing the use of materials and equipment in the clean and flush process. Provide a piping drawing or schematic indicating piping system boundary. Provide the plan prior to the start of work. The plan must be approved by the Company.

B. Provide a disposal plan for contaminated system cleaning fluids and flushing fluids, chemicals, filters, sediment, and any other media including appropriate permits to discharge to sanitary sewer (if acceptable) or for the removal of such items from the site. Provide the plan prior to the start of work. The plan must be approved by the Company.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning chemicals will be supplied to the Seller by the Company. The Seller shall provide calculated system water volume to the Company to determine quantity of chemical needed.

B. Corrosion inhibitor will be provided to the Seller by the Company.

C. Potable water will be provided to the Seller by the Company. The Seller is responsible for providing a back flow preventer on the potable water system to effectively make process water to be used in the cleaning, flushing and system filling processes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Ensure pipe and components are free from physical defects.

3.2 APPLICATION FOR HEATING WATER AND CHILLED WATER SYSTEMS

A. Chilled water and heating water systems shall be cleaned prior to start-up per the following:
1. Isolate any equipment that could be harmed by purging, cleaning or flushing activities. This includes any equipment that may be damaged by the pressures and chemicals involved with this process. Ensure that the rest of the system is open to flow and all control valves are 100% open.
2. Ensure no dead legs exist in the system. If a dead leg does exist, a drain leg or a by-pass shall be added at the seller’s expense.
3. The chemicals used in the cleaning process can cause an exothermic reaction. Appropriate measures shall be taken to ensure that this heat load will be removed from the system or that the increased temperatures will not harm the system in any fashion.
4. Standard chilled water and heating water systems shall be filtered to 100 microns during the cleaning and flushing process. Chilled water systems connected and/or supplying a supercomputing system shall be filtered to 1 micron during the cleaning and flushing process.
5. Fill the system with clean water and add cleaning chemicals to the system to a 1% concentration based on total system volume that is 10 gallons of chemical to 1000 gallons of water. Use ChemTreat CN3803, which will be supplied by the Company. Use proper PPE when handling chemicals. Purge air from system high points.
6. Start pumps and begin circulation. Circulation rate shall be at the minimum pipe velocity of 6fps for pipe sizes 24 inches and below or at design rate if greater. Monitor for leaks throughout the cleaning and flushing process and take appropriate action should one be found.
7. PH and conductivity levels shall be monitored and recorded every four hours. Add necessary chemicals to regulate pH and conductivity to appropriate levels. Maintain pH level between 7.0 and 8.5 using ChemTreat CN3803 as necessary.
8. Monitor all pressure differentials across strainers and filters. Stop circulation if pressure differentials exceed recommended values and change filters and blow out strainers as needed. Continue cleaning process once the system is ready again.
9. Monitor system temperature and pressure. Ensure pressure at the indicated temperature does not exceed that specified for system components.
10. After system cleaning fluid has been circulated for a total of 72 hours (not including any downtime) and pH, conductivity, and temperatures have stabilized, system cleaning is complete. Proceed to flushing section.

B. Chilled water and heating water systems shall be flushed prior to start-up per the following:
   1. See Section 3.4 Disposal of Cleaning Fluids. If Seller does not have a permit to discharge to the Companies Sanitary Treatment Plant (STP), the Seller is responsible for removing contaminated cleaning and flushing water from the site.
   2. While continuing to circulate and filter, drain water from the system, including dead legs, at no more than 5 GPM total while simultaneously making up at equal flow rate from a process water source.
   3. Drain to sanitary with a hose if permitted or to Seller provided tanker truck for site removal.
   4. Continue until the discharge water is clear and will not foam when poured into a bucket. The draining water chemistry should approach that of the make-up water - typically a conductivity of 300 µmhos, and a pH of approximately 7.0. Do not stop pump circulation at any time as suspended matter will settle and accumulate at system low points.
   5. Replace all filters with new filters, clean all strainers, and blow out all low system points.
   6. Reconnect systems components that were disconnected for the cleaning and flushing process.

C. Chilled water and heating water systems shall be treated with a corrosion inhibitor after system flushing is complete and prior to being put into service per the following:
   1. Through the shot feeder, add the initial dose of water treatment chemicals to permanently treat the system. Water treatment chemicals will be supplied by the Company.
   2. Request the Company's water treatment representative certify the initial condition of the circulated water.
   3. Request the Company's Mechanical Utilities Division to put the system into operation.

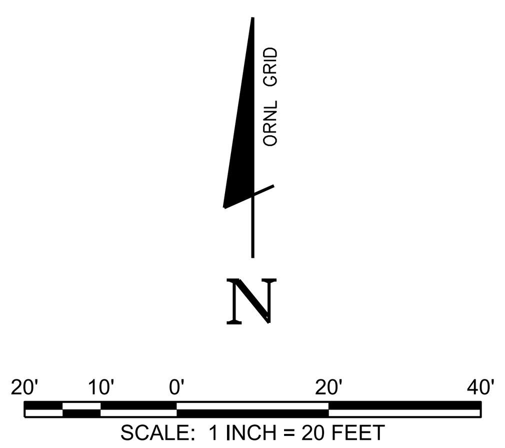
3.3 APPLICATION FOR COOLING TOWER WATER SYSTEMS

A. Cooling tower water systems shall be flushed prior to start-up per the following:
   1. Isolate any equipment that could be harmed by the purging or flushing action. Ensure that the rest of the system is open to flow and all control valves are 100% open.
   2. Fill the system from a process water source. Insure chemical treatment system is turned off.
   3. Start pumps and begin circulation. Circulation rate shall be at the minimum pipe velocity of 6fps for pipe sizes 24 inches and below or at design rate if greater. Monitor for leaks throughout the flushing process and take appropriate action should one be found.
   4. Monitor all pressure differentials across strainers and blow them out as needed.
   5. Inspect tower basin for sediment buildup and clean as necessary.
   6. Flushing circulation shall be done for 24 hours excluding any downtime.
   7. Replace all filters with new filters, clean all strainers, and blow out all low system points.
   8. Reconnect systems components that were disconnected for the flushing process.
   9. Fill system to operating level.
   10. Request the Company's water treatment representative enable the chemical treatment system.
   11. Circulate for 1 hour, to allow chemicals to mix.
   12. Request the Company's water treatment representative certify the initial condition of the circulated water.
   13. Request the Company's Mechanical Utilities Division to put the system into operation.

3.4 DISPOSAL OF CLEANING FLUIDS

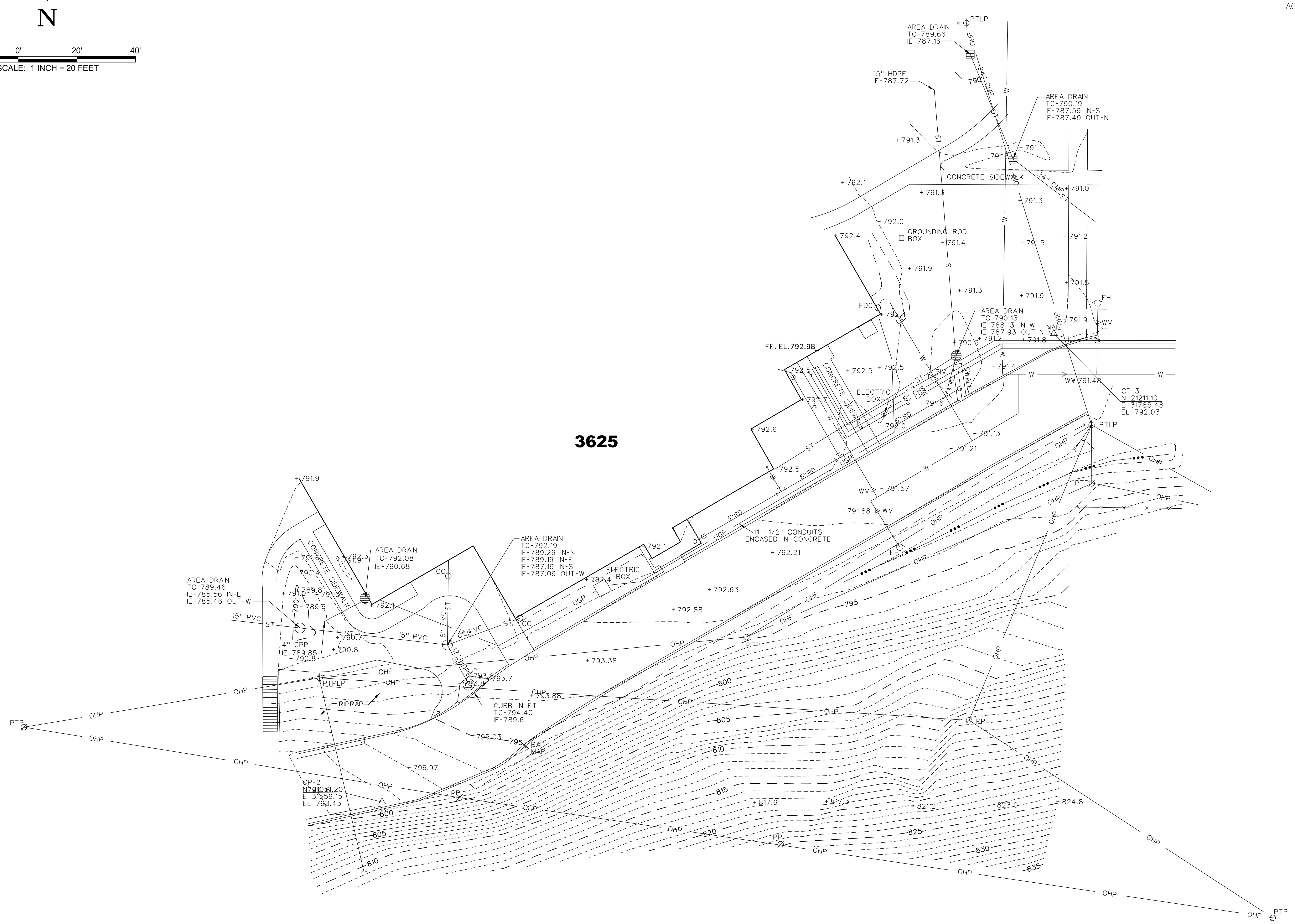
A. Disposal of pipe cleaning chemicals and flushing water shall be the responsibility of the Seller. However, the Company may provide the Seller with an option to dispose of the pipe cleaning chemicals and flush water using the Company's Sanitary Treatment Plant (STP), provided that the flush water meets the Waste Acceptance Criteria (WAC) for the Company's STP. Flush water that exceeds the WAC may be allowed on a case by case basis provided a variance to the WAC is approved prior to discharge. If the cleaning materials and flush water is disposed in the STP, the Seller shall be responsible for Company imposed costs associated with the disposal and shall be responsible to discharge the waste at the flow rate determined by the Company

END OF SECTION 33 61 24



NOTES:

1. **UTILITIES THAT ARE VISIBLE** (ABOVE GRADE AND OVERHEAD) AND RELATED EQUIPMENT AND APPURTENANCES (POLE, WIRES, VALVES, MANHOLES, ETC.) ARE SHOWN BY FIELD LOCATION TO THE LEVEL OF DETAIL AND ANNOTATION REQUESTED BY THE CLIENT. **UNDERGROUND UTILITIES ARE NOT VISIBLE.** THEREFORE THEY ARE SHOWN BASED ON AVAILABLE AS-BUILT AND INVENTORY MAPS (IF ANY) FROM THE UTILITY OWNER AND FIELD LOCATION OF UTILITY TRACER MARKINGS AND PAINT (IF ANY) BY OTHERS. THE LOCATION AND INVENTORY IS THE RESULT OF NORMAL DUE DILIGENCE, HOWEVER THE **SURVEYOR MAKES NO WARRANTY OR GUARANTEE** THAT ADDITIONAL UTILITIES, ACTIVE OR ABANDONED DO NOT EXIST AND WITHOUT VERIFICATION VIA EXCAVATION, THIS MAP'S REPRESENTATION OF THE UTILITIES MAY DIFFER FROM ACTUAL LOCATION.



LEGEND

ISN	Iron Spike Set
AI	Angle Iron Found
PKO	PK Nail Found
IRO	Iron Rod Found
IRN	Iron Rod Set
AC	AC Unit
PTP	Power/Tel Pole
	Landscape Lamp
MB	Mail Box
WM	Water Meter
GV	Gas Valve
WV	Water Valve
FH	Fire Hydrant
SN	Sign
CO	Clean Out
SAMH	Sanitary ManHole
GM	Gas Meter
ST	Underground Storm Sewer
W	Underground Waterline
UGP	Underground Power
UGT	Underground Telephone
G	Underground Gasline
OHPT	Overhead Power/Telephone Line
OHP	Overhead Power

BARGE DESIGN SOLUTIONS
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TOPOGRAPHIC SURVEY

BUILDING 3625
OAK RIDGE NATIONAL LABORATORY
OAK RIDGE, TENNESSEE

REVISION INFORMATION

REV.	DR.	CHK.	DATE	DESCRIPTION
0	SCJ	MFW	02/18/2022	ORIGINAL ISSUE

FILE NO. 37195-00

2/25/2022
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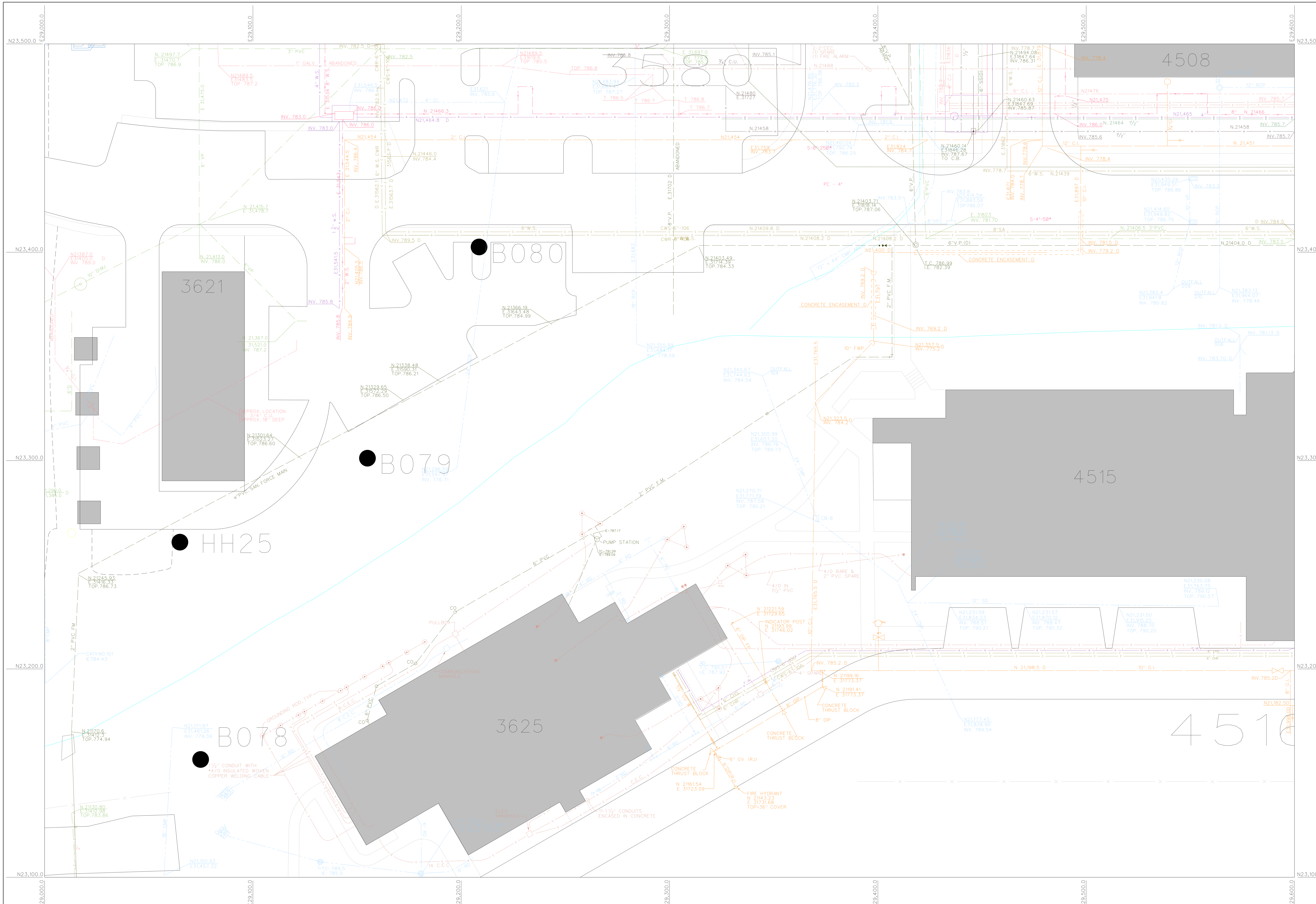

ORNL ATLAS SHEET

LEGEND

FENCE
CHAIN BARRIER & GUARD RAIL
STEAM LINE, UNDERGROUND
STEAM LINE, ABOVEGROUND
CONDENSATE LINE
UNDERGROUND TELEPHONE
DIRECT BURIAL TELEPHONE
STORM DRAINS
POTABLE WATER LINE
PROCESS WATER LINE
IRRIGATION WATER LINE
DISTILLED WATER LINE
SANITARY SEWER
PROCESS SEWER
NATURAL GAS
OFF GAS
LOW LEVEL WASTE
COOLING WATER LINE
DEMINERALIZED WATER
FUEL LINE
CHEMICAL LINE
HYDROGEN OR HELIUM LINE
OXYGEN LINE
NITROGEN LINE
VACUUM LINE
UNDERGROUND ELECTRICAL
DIRECT BURIAL ELECTRIC CABLE
AIR LINE
EXHAUST DUCT
RAW WATER

NOTES:
1. COORDINATES AND ELEVATIONS OF UNDERGROUND INSTALLATIONS SHOWN WITH THE LETTER "D" ARE DESIGN DATA.
2. UTILITY LINES SHOWN AS SOLID LINES ARE REFERENCED FROM SCHEMATIC DATA AND ARE NOT COORDINATELY PRECISE.
3. KNOWN ABANDONED UTILITIES ARE DENOTED WITH THINNER LINE WEIGHTS EXAMPLE:
IN-SERVICE POTABLE WATER
ABANDONED POTABLE WATER

ORNL GRID NORTH
TRUE NORTH

0 10 20 30 40 50
SCALE IN FEET

NOT FOR PUBLIC RELEASE

THE ELECTRONIC VERSION OF THIS DRAWING IS THE RECORD COPY. ACCESS PROJECTWISE TO VERIFY THE LATEST REVISION.

13-JUN-2021

REFER TO ATLAS COMPOSITE DRAWING FOR SHEET ORIENTATION

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE US DEPARTMENT OF ENERGY
Facilities and Operations Directorate
Operated for the Department of Energy under the Government of the United States of America

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27	34	41
28	35	42

34
SHEET NO.

DRAWING NO. XXXXXXX REV X

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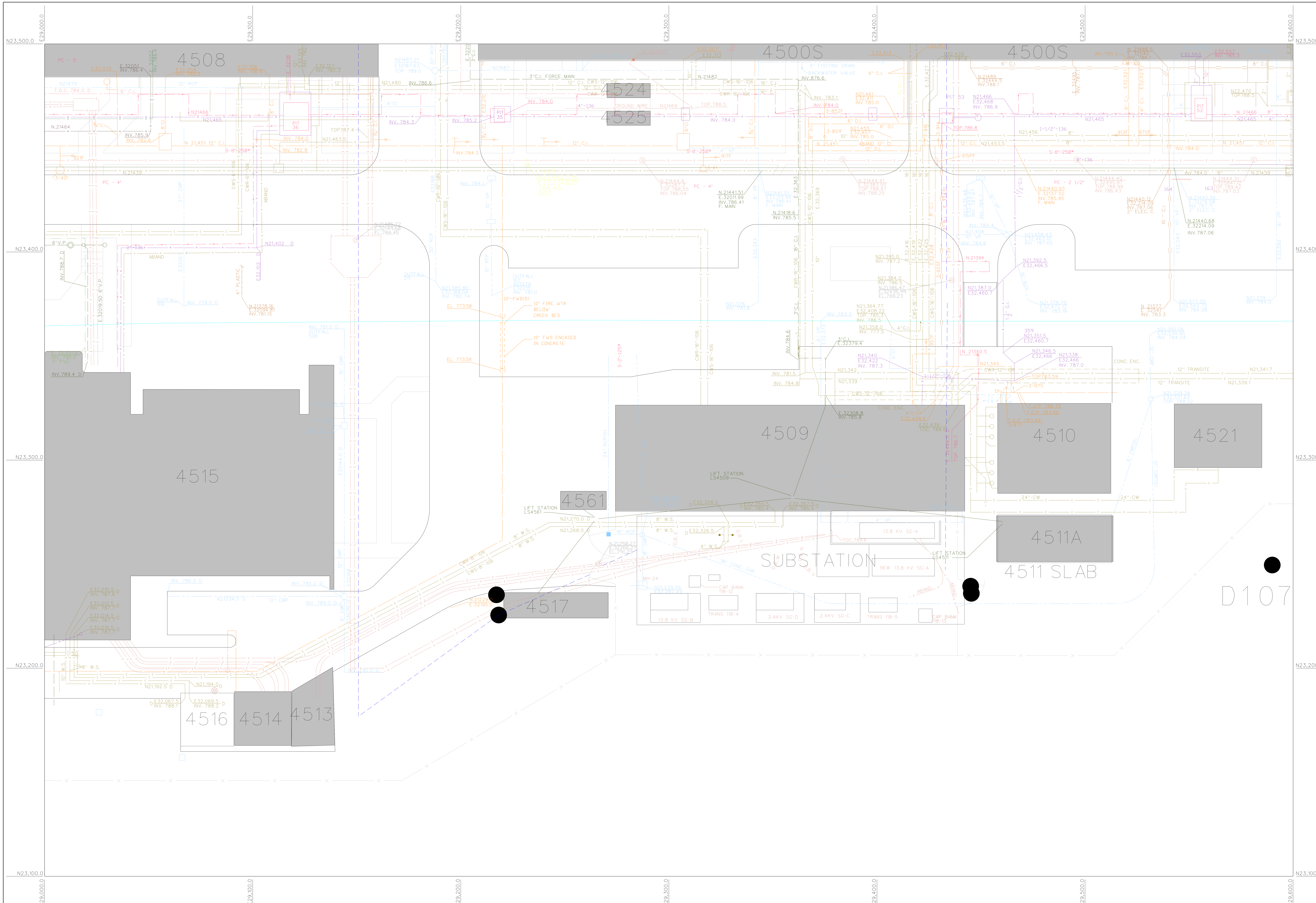
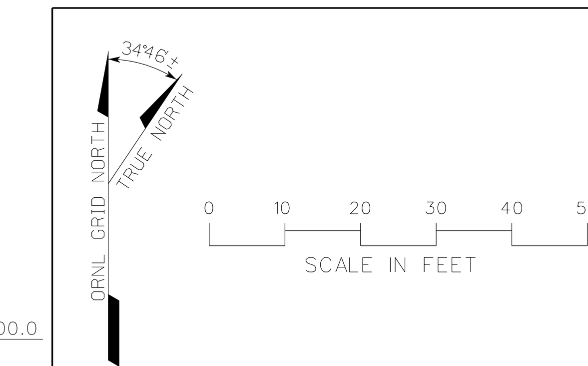


ORNL ATLAS SHEET

LEGEND

- FENCE
- CHAIN BARRIER & GUARD RAIL
- STEAM LINE, UNDERGROUND
- STEAM LINE, ABOVEGROUND
- CONDENSATE LINE
- UNDERGROUND TELEPHONE
- DIRECT BURIAL TELEPHONE
- STORM DRAINS
- POTABLE WATER LINE
- PROCESS WATER LINE
- IRRIGATION WATER LINE
- DISTILLED WATER LINE
- SANITARY SEWER
- PROCESS SEWER
- NATURAL GAS
- OFF GAS
- LOW LEVEL WASTE
- COOLING WATER LINE
- DEMINERALIZED WATER
- FUEL LINE
- CHEMICAL LINE
- HYDROGEN OR HELIUM LINE
- OXYGEN LINE
- NITROGEN LINE
- VACUUM LINE
- UNDERGROUND ELECTRICAL
- DIRECT BURIAL ELECTRIC CABLE
- AIR LINE
- EXHAUST DUCT
- RAW WATER

NOTES:
1. COORDINATES AND ELEVATIONS OF UNDERGROUND INSTALLATIONS SHOWN WITH THE LETTER "D" ARE DESIGN DATA.
2. UTILITY LINES SHOWN AS SOLID LINES ARE REFERENCED FROM SCHEMATIC DATA AND ARE NOT COORDINATELY PRECISE.
3. KNOWN ABANDONED UTILITIES ARE DENOTED WITH THINNER LINE WEIGHTS EXAMPLE:
   - IN-SERVICE POTABLE WATER
   - ABANDONED POTABLE WATER



NOT FOR PUBLIC RELEASE

THE ELECTRONIC VERSION OF THIS DRAWING IS THE RECORD COPY. ACCESS PROJECTWISE TO VERIFY THE LATEST REVISION.

13-JUN-2021

REFER TO ATLAS COMPOSITE DRAWING FOR SHEET ORIENTATION

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE US DEPARTMENT OF ENERGY
Facilities and Operations Directorate

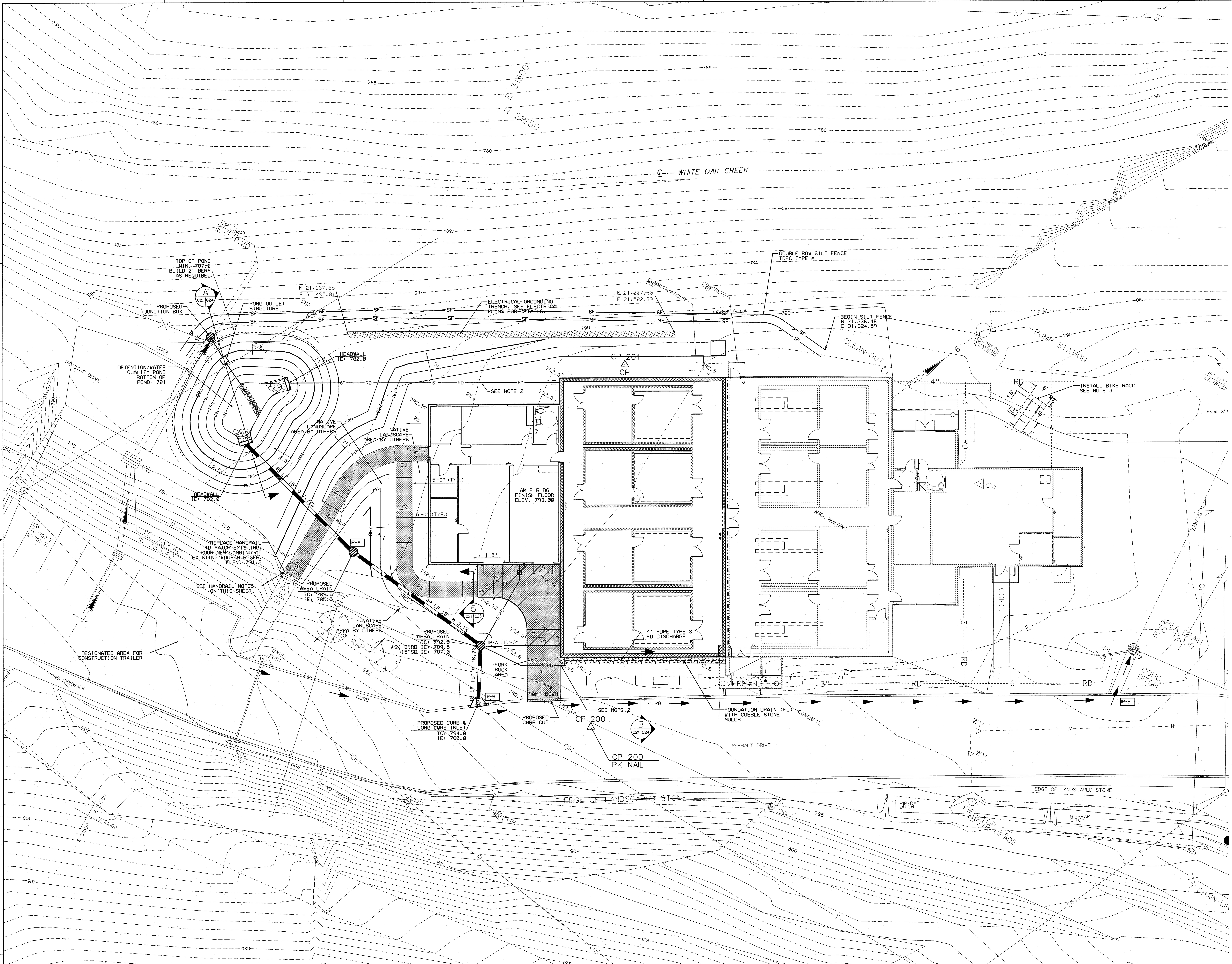
33	40	47
34	41	48
35	42	49

41
SHEET NO.

DRAWING NO. XXXXXXX

REV. X

$FILEL$



NOTES:

1. SEE DRAWING C3E021544B020 FOR GENERAL NOTES AND LEGEND.
2. ROOF DRAIN LATERALS SHALL BE SCHEDULE 40 PVC.
3. SELLER TO PURCHASE AND INSTALL BIKE RACK NEAR MAIN ENTRANCE OF EXISTING AML BUILDING AT LOCATION APPROVED BY COMPANY. BIKE RACK TO BE 2-BIKE INVERTED-U, IN GROUND MOUNT COMMERCIAL GRADE BIKE RACK (MODEL NO. 116-1009) BY HIGHLAND PRODUCTS GROUP, LLC OR APPROVED EQUIVALENT. BIKE RACK SHALL BE MOUNTED IN A NEW CONCRETE PAD AT APPROVED LOCATION. POST HOLE SHALL BE 11" DIAMETER BY 17" DEEP WITH 6" OF GRAVEL AT BASE AND CONCRETE ABOVE.

EROSION CONTROL LEGEND

SF	SILT FENCE (TDEC TYPE A)
IP-A	STREAMGUARD SEDIMENT INSERT (BOWHEAD ENVIRONMENTAL & SAFETY, 1800-909-3677) OR EQUAL
IP-B	STREAMGUARD CURB INSERT (BOWHEAD ENVIRONMENTAL & SAFETY, 1800-909-3677) OR EQUAL, WITH SAND BAGS OVER CURB OPENING

HANDRAIL NOTES:

1. PROVIDE NEW HANDRAIL TO MATCH THE EXISTING IN STYLE, TYPE AND HEIGHT.
2. NEW HANDRAIL SHALL BE ATTACHED TO THE NEW CONCRETE WALK BY CORE DRILLING THE WALK A MINIMUM OF 4" DEEP FOR PLACEMENT OF NEW VERTICAL RAIL POST. PROVIDE NON-SHRINK GROUT AROUND THE BASE OF THE VERTICAL RAIL TO SECURE RAILING TO THE WALKWAY.
3. NEW RAIL SHALL BE GALVANIZED TO MATCH THE EXISTING.
4. NEW RAIL SHALL EXTEND 24 INCHES PAST THE LAST VERTICAL RISER OF THE STEPS AND SHALL MATCH THE EXISTING.
5. FIELD WELD NEW RAILING TO THE EXISTING RAILING AND GRIND ALL CONNECTIONS SMOOTH. PROVIDE GALVANIZE COATING TO MATCH THE EXISTING.
6. PROVIDE A LIGHT BROOM FINISH ON THE NEW WALKWAY/LANDING AT THE BASE OF THE STAIRS.
7. RAILING TRANSITION AT THE TOP FROM HORIZONTAL TO VERTICAL SHALL UTILIZE A RADIUS EDGE TO MATCH THE EXISTING.
8. HEIGHT OF THE TOP OF THE RAIL SHALL BE 36 INCHES ABOVE THE NEW WALKWAY/LANDING.

SECTION AND DETAIL KEY

NUMBER OF SECTION OR DETAIL
DRAWING ON WHICH SECTION OR DETAIL IS TAKEN
DRAWING ON WHICH SECTION OR DETAIL IS SHOWN

THIS DOCUMENT CONTROLLED BY
CHANGE CONTROL SYSTEM ______
ENGINEERING PROCEDURE ______

REV	CHANGE TYPE	DESCRIPTION
0	---	ISSUED - CERTIFIED FOR CONSTRUCTION

REVISION OR ISSUE PURPOSE — REVISION APPROVALS — INTER-DISCIPLINE CHECK

RPE: BENJAMIN C. NEMEC, REGISTERED ENGINEER, AGRICULTURE, COMMERCE, No. 104112, STATE OF TENNESSEE

REV. 0 — DATE 8/28/09

DSGN	B. NEMEC	08/28/09
DRW	B. PETERSON	08/28/09
CHKR	M. POE	08/28/09
PE	J. H. Corley	9/2/09
PM	J. A. Mayo	9/01/09
REQ		9/1/09
CFM		9/1/09
REVISION 0 APPROVALS		DATE

BWSC Barge Waggoner Sumner & Cannon, Inc.
10133 Sherrill Blvd., Suite 200, Knoxville, Tennessee 37932
PHONE (865) 637-2810 FAX (865) 673-8554

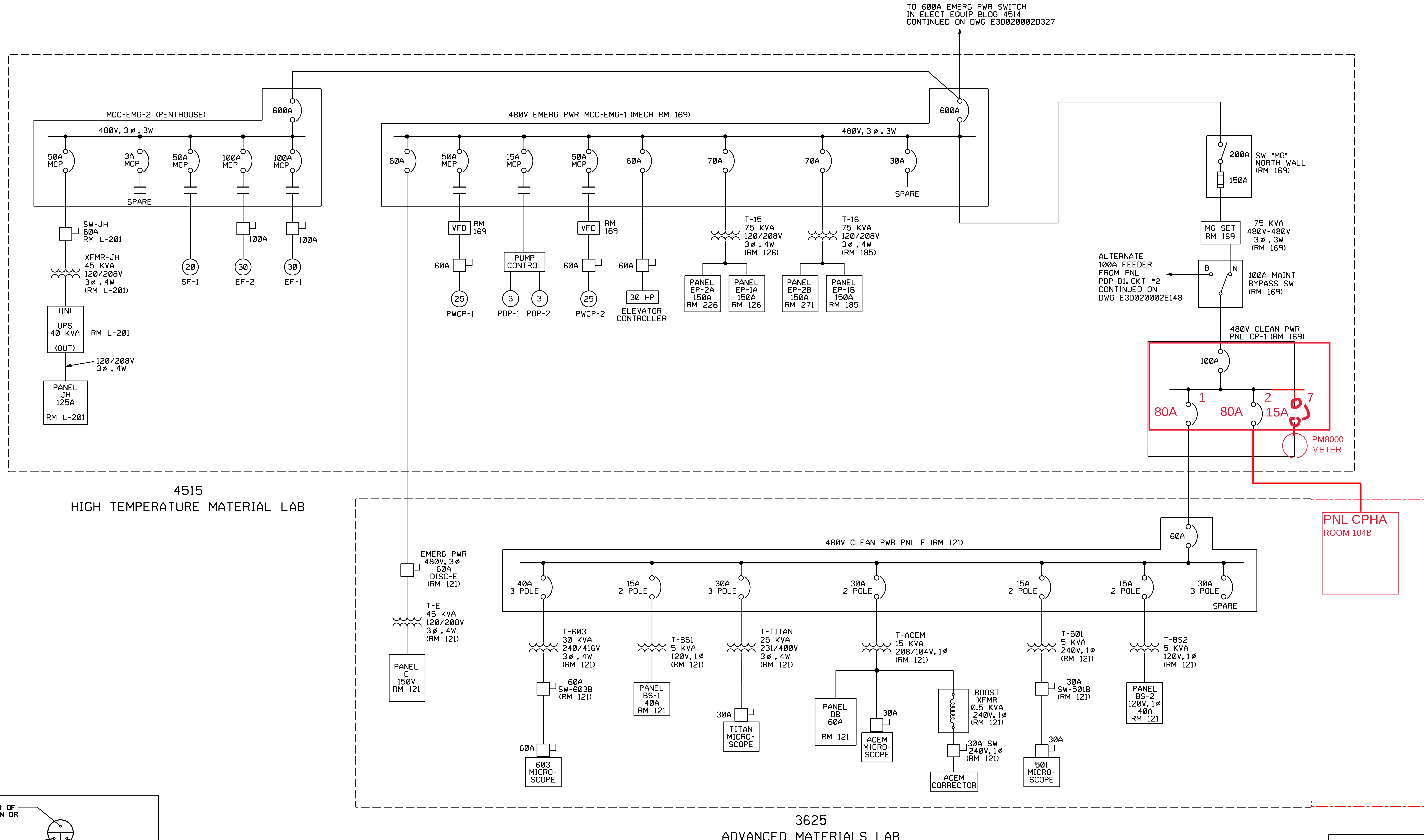
UT-BATTELLE
Oak Ridge National Laboratory
managed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC05-00OR22725
UT-BATTELLE, LLC, • Oak Ridge, Tennessee

PROJECT NAME:
ADV MICROSCOPY LAB EXPANSION

SITE, GRADING, DRAINAGE & EROSION CONTROL PLAN

SITE	BLDG	FL	SH.	OF	
ORNL	3625	1	1	1	UNCLASSIFIED

DRAWING NUMBER C3E021544B021 — REV 0



NUMBER OF SECTION OR DETAIL
DRAWING ON WHICH SECTION OR DETAIL IS TAKEN
DRAWING ON WHICH SECTION OR DETAIL IS SHOWN

SECTION AND DETAIL KEY

REFERENCE DOCUMENTS	DRAWING NO.
STATION 216-10B ONE LINE DIAGRAM	E3D020002E148
STATION 216-9A & 216-10B ONE LINE DIAGRAM	E3D020002D327

THIS DOCUMENT CONTROLLED BY
CHANGE CONTROL SYSTEM ______
ENGINEERING PROCEDURE ______

REV	CHANGE TYPE	CHANGE CONTROL SYSTEM	CHANGE REQUEST NUMBER	DESCRIPTION	DSN	CHK	DEPT	DATE	PE	DATE	PM	DATE	REQ	DATE	RPE	RPE NO	DATE	EC	EE	EM	IE	AR	FPE
0	—	—	—	ORIGINAL	RPP	CT	WKT	11/07															

REVISION OR ISSUE PURPOSE — REVISION APPROVALS — SQUAD CHECK

RPE	DSGN	R P POLAND	06/14/07
	DRW	D E SMITH	06/14/07
	CHKR	C TAVINO	11/2/07
	DEPT	W K THOMAS	11/2/07
	PE		
	PM		
	REQ		
REV. DATE	DRAWING APPROVALS		DATE

UT-BATTELLE

Oak Ridge National Laboratory
managed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC05-00OR22725
UT-BATTELLE, LLC. • Oak Ridge, Tennessee

PROJECT NAME:
ELECT DIST SYS - STA 216-9A (EMERG)

ORNL ELECTRICAL SYSTEM
STATION 216-9A (EMERG)
ONE LINE DIAGRAM

SITE	BLDG	FL	SH.	OF	
ORNL	XAREA-02	X	1	1	UNCLASSIFIED

DRAWING NUMBER: E3D020002E147 REV 0

E3D020002E147

$FILE$

LEGEND

(red line)	2400V FEEDERS
(dashed line)	UNDERGROUND FEEDERS
(purple dash-dot line)	TVA OWNED POWER LINES
(solid line)	FEEDERS (COLORS DENOTE DIFFERENT FEEDER NUMBERS)

MAIN CAMPUS AREA - AREA 5

SCALE: 1" = 100'

REFERENCE DWG.

E3D020002F501	MAIN CAMPUS AREA SITE PLAN

ISSUED IN ACCORDANCE WITH:
CHANGE CONTROL SYSTEM 4
F&O PROCEDURE MPO-DM-330

REV.	CHANGE TYPE	CHANGE CONTROL SYSTEM	CHANGE REQUEST NUMBER	DESCRIPTION	DSN	DATE	CHK	DATE
0	---	4	---	ORIGINAL ISSUE	PRL	6/19	MAB	6/19

REVISION LEVEL — REVISION OR ISSUE PURPOSE — REVISION OR ISSUE REVIEWERS (RPE/RA, RPE NO, DATE, PE/A, DATE, PM, DATE, REQ, DATE, CFM, DATE) — INTER-DISCIPLINE CHECK (C/ST, EC, EE, EM, AR, FPE) — RPE / RA — REV. — DATE — REVISION 0 ISSUANCE — DATE

DSGN	P.R. LAWLOR	06/04/19
DRW	J.D. THATCHER	06/04/19
CHKR	M.A. BARCIO	06/04/19
PE/A		/ /
PM		/ /
REQ		/ /
CFM		/ /
	D.F. BELCHER	06/04/19

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE US DEPARTMENT OF ENERGY
Facilities and Operations Directorate
Operated for the Department of Energy under the Government of the United States of America

PROJECT NAME:
ELECTRICAL DISTRIBUTION SYSTEM POLE PLANS

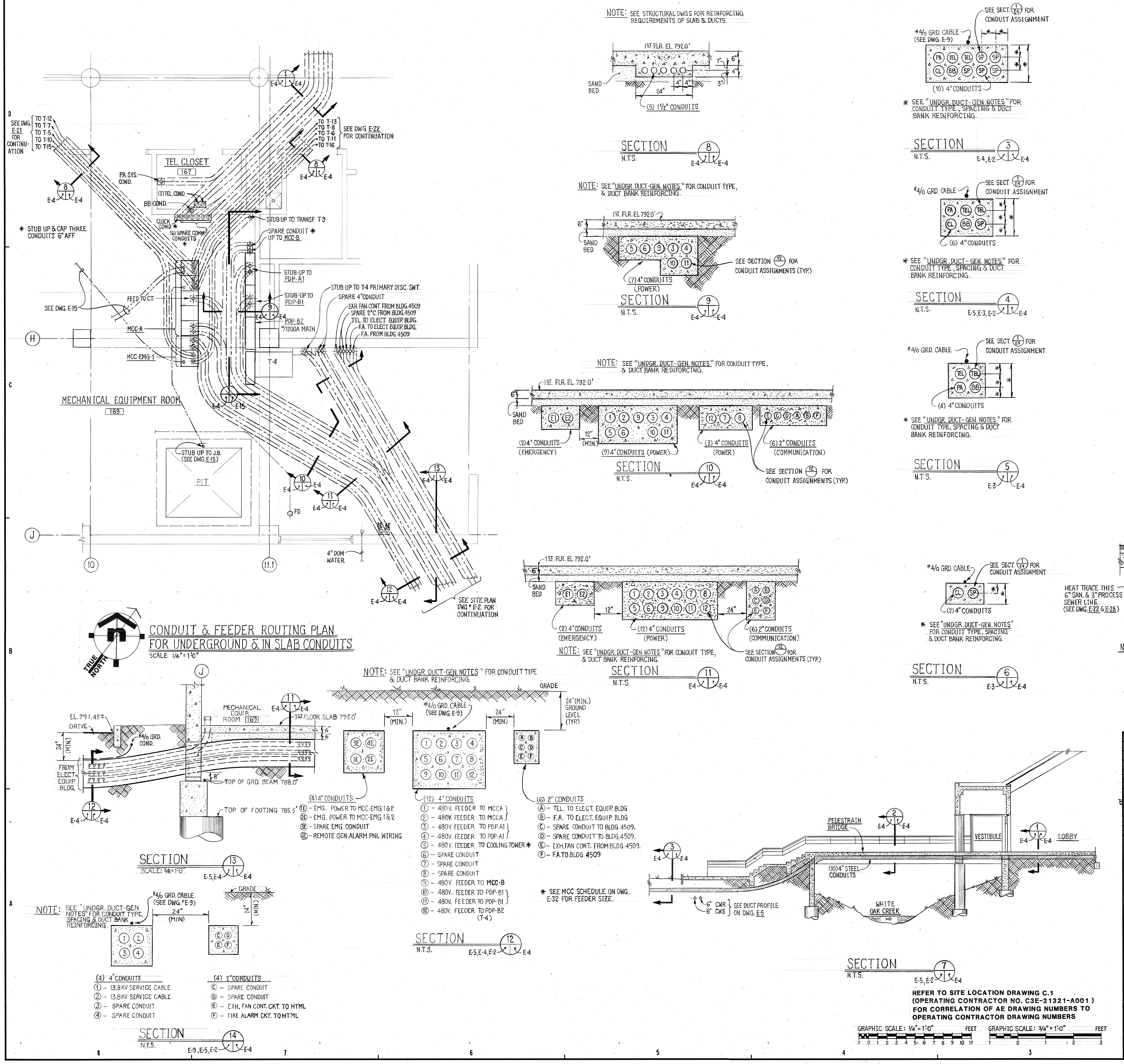
MAIN CAMPUS
AREA
AREA 5

SITE	BLDG	FL	SH	OF	
ORNL	XAREA-02	X	1	1	UNCLASSIFIED

PROJECT RECORD NUMBER	DRAWING NUMBER	REV
X2014-0012	E3D020002F519	0

E3D020002F519

$DATE$
$FILE$



UNDERGROUND DUCT - GENERAL NOTES:

1). ALL UNDERGROUND CONDUITS SHALL BE P.V.C. AND SHALL BE CONCRETE ENCASED, UNLESS OTHERWISE NOTED. ALL SUCH ENCASEMENTS, CONFIGURATIONS, CONDUIT SPACING & REINFORCEMENT SHALL CONFORM TO REQUIREMENTS OF MM-ES ENGINEERING STANDARD ES-1.20

2). ALL CONCRETE ENCASEMENTS (EXCEPT UNDER ROADWAYS AND DRIVES) SHALL BE REGULAR DUCT BANK CONSTRUCTION WITH P.V.C. CONDUITS, UNLESS OTHERWISE NOTED ON THE DRAWINGS.

3). ALL DUCT BANKS PASSING UNDER ROADWAYS AND DRIVES SHALL BE OF HEAVY REINFORCED TYPE CONSTRUCTION. EACH DUCT BANK SHALL BE REINFORCED BENEATH THE ROADWAY OR DRIVE AND WITH-IN 10'-0" OF EACH SIDE OF ROADWAY OR DRIVE.

4). ALL ROADWAY SURFACES & BASES, CURBS, SIDEWALKS, & SOD AREAS SHALL BE RESTORED TO THEIR ORIGINAL CONDITION AFTER DUCT INSTALLATION.

5). TELEPHONE CONDUITS SHALL CONTAIN SOFT IRON PULL WIRES. WIRE SHALL BE #14 AWG. FOR CONDUITS LESS THAN 100 FT. OR #10 AWG. FOR CONDUITS LONGER THAN 100 FT.

6). ALL "SPARE" OR "EMPTY" CONDUITS SHALL CONTAIN A 1/4" THK. 1500 LBS. NYLON PULL ROPE.

CONDUIT ASSIGNMENT LEGEND

SP = SPARE CONDUIT.
TEL = TELEPHONE
PA = PUBLIC ADDRESS
CL = CLOCK CKT.
BB = BROADBAND (.750") CABLE

(4) 4" CONDUITS
(1E) - EMG. POWER TO MCC-EMG.1 & 2
(2E) - EMG. POWER TO MCC-EMG.1 & 2
(3E) - SPARE EMG. CONDUIT
(4E) - REMOTE GEN. ALARM PNL WIRING

(12) 4" CONDUITS
(1) - 480V. FEEDER TO MCCA
(2) - 480V. FEEDER TO MCCA
(3) - 480V. FEEDER TO PDP-A1
(4) - 480V. FEEDER TO PDP-A1
(5) - 480V. FEEDER TO COOLING TOWER *
(6) - SPARE CONDUIT
(7) - SPARE CONDUIT
(8) - SPARE CONDUIT
(9) - 480V. FEEDER TO MCC-B
(10) - 480V. FEEDER TO PDP-B1
(11) - 480V. FEEDER TO PDP-B1
(12) - 480V. FEEDER TO PDP-B2 (T-4)

(6) 2" CONDUITS
(A) - TEL. TO ELECT. EQUIP. BLDG
(B) - F.A. TO ELECT. EQUIP. BLDG
(C) - SPARE CONDUIT TO BLDG. 4509.
(D) - SPARE CONDUIT TO BLDG. 4509.
(E) - EXH. FAN CONT. FROM BLDG. 4509.
(F) - F.A. TO BLDG 4509

* SEE MCC SCHEDULE ON DWG. E-32 FOR FEEDER SIZE.

(4) 4" CONDUITS
(1) - 13.8KV SERVICE CABLE
(2) - 13.8KV SERVICE CABLE
(3) - SPARE CONDUIT
(4) - SPARE CONDUIT

(4) 2" CONDUITS
(C) - SPARE CONDUIT
(D) - SPARE CONDUIT
(E) - EXH. FAN CONT. CKT. TO HTML
(F) - FIRE ALARM CKT. TO HTML

REFER TO SITE LOCATION DRAWING C.1 (OPERATING CONTRACTOR NO. C3E-21321-A001) FOR CORRELATION OF AE DRAWING NUMBERS TO OPERATING CONTRACTOR DRAWING NUMBERS

GRAPHIC SCALE: 1/4"=1'0" FEET
GRAPHIC SCALE: 3/4"=1'0" FEET

REV. NO.	ISSUE OR REVISION - PURPOSE	INITIALS AND DATE		
1	REVISED TO AS BUILT 9/30/87	EFO		
0	ISSUED FOR CONSTRUCTION	JDK	JAM	WCG
		A-E	OPERATOR	DOE

SQUAD CHECK: GKC, PAC, JES, TEK (JL), JES, JEH

WORK ORDER NO. K-7062A
SECOND NO. ACCOUNT
PROCUREMENT BY FPPC
INSTALLATION BY FPPC

UNITED STATES DEPARTMENT OF ENERGY

DRS — Deeter Ritchey Sippel Architects/Planners, Four Gateway Center, Pittsburgh, PA 15222

DOE CONTRACT NO. DE-AC05-840R21361 A-E NO. 1494

HIGH TEMPERATURE MATERIALS LABORATORY
OAK RIDGE NATIONAL LABORATORY
ELECTRICAL
UNDERGROUND DUCT DETAILS

HTML-UNDERGR. DUCT. DET

DRAWN BY	DATE	DESIGNED AND CHECKED BY	DATE	CHECKED BY	DATE
E.F.O.	7-30-84	T.E.K.	7-30-84	JHKY	7-30-84

PLANT	BLDG	FLOOR	SCALE	1	48	49	50	TYPE	CLASS
X-10	4515	–	AS NOTED	3	E	U	K	S	U

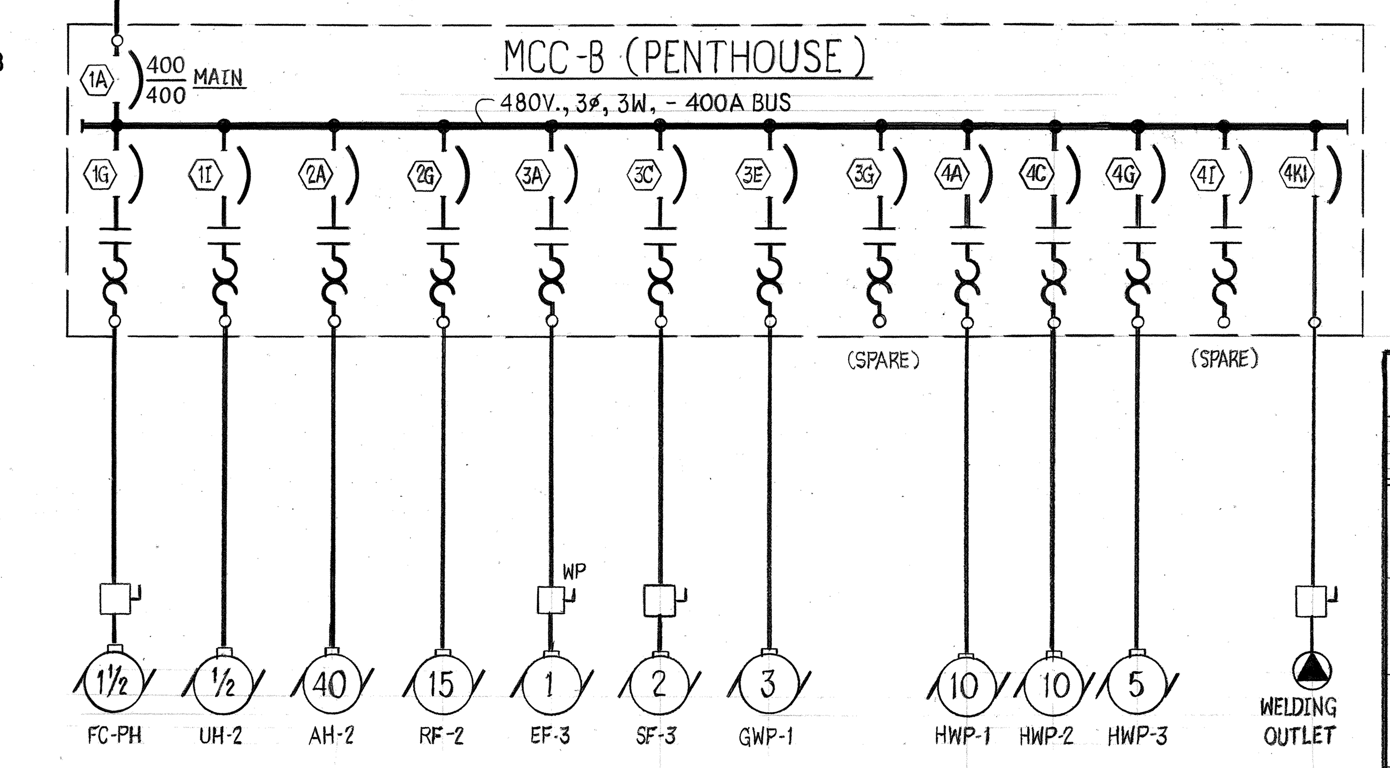
SUBMITTED FOR APPROVAL: J.D. KLING 9-18-84 (A-E)
APPROVAL RECOMMENDED: J.A. MURRAY 9-18-84 (OPERATING CONTRACTOR)
DRAWING APPROVED: W.C. GILBERT 9-18-84 (DOE)

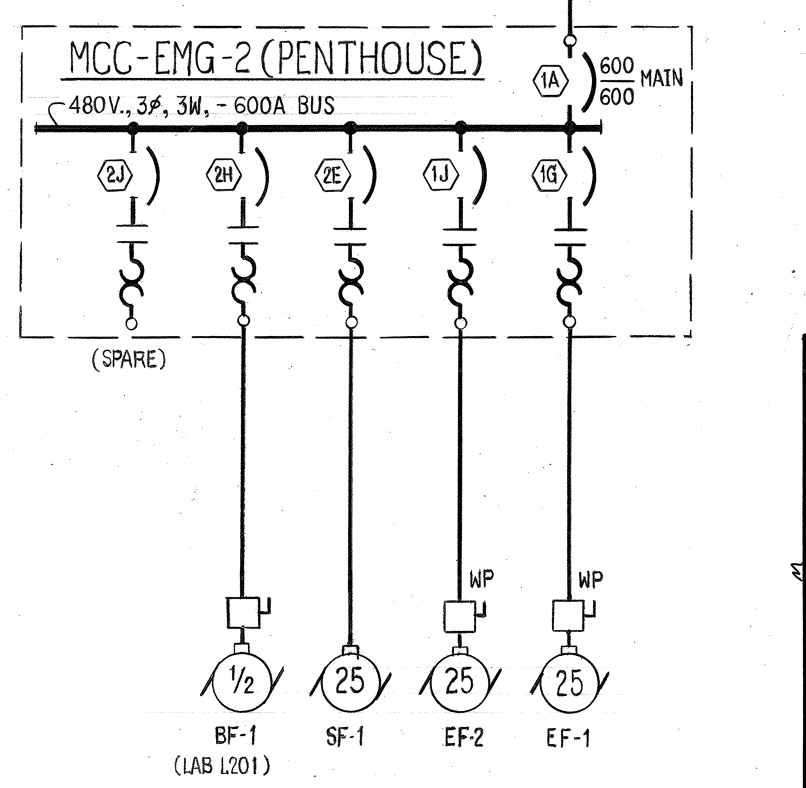
DRAWING NO. E-4 E3E-21321-D005 REV. NO. 1

A. M. Kinney, Inc.

122

SINGLE LINE DIAGRAM
HTML BUILDING





TRANSFORMER SIZE & CONNECTION SCHEDULE

TRANSF. Nº.	KVA	PHASE	PRIMARY VOLTS	SECONDARY VOLTS	FEEDER SIZE - (SEE FEEDER SCHEDULE ◉) PRIMARY FEEDER	SECONDARY FEEDER	NEUTRAL/GRD.	REMARKS
T-4	300	3	480	208Y/120	400A, 3∅, 3W	1000A, 3∅, 4W	#3/0	
T-5	45	3	480	208Y/120	70A, 3∅, 3W	(8)#1/0 & (2)#6G. - 3"C.	2	*
T-6	45	3	480	208Y/120	70A, 3∅, 3W	(8)#1/0 & (2)#6G. - 3"C.	2	*
T-7	45	3	480	208Y/120	70A, 3∅, 3W	(8)#1/0 & (2)#6G. - 3"C.	2	*
T-8	45	3	480	208Y/120	70A, 3∅, 3W	(8)#1/0 & (2)#6G. - 3"C.	2	*
T-9	45	3	480	208Y/120	70A, 3∅, 3W	(4)#1/0 & (2)#6G. - 3"C.	2	*
T-10	45	3	480	208Y/120	70A, 3∅, 3W	(8)#1/0 & (2)#6G. - 3"C.	2	*
T-11	45	3	480	208Y/120	70A, 3∅, 3W	(8)#1/0 & (2)#6G. - 3"C.	2	*
T-12	45	3	480	208Y/120	70A, 3∅, 3W	(8)#1/0 & (2)#6G. - 3"C.	2	*
T-13	45	3	480	208Y/120	70A, 3∅, 3W	(8)#1/0 & (2)#6G. - 3"C.	2	*
T-14	15	1	480	120/240	30A, 1∅, 2W	60A. 1∅, 3W.	-	SEE DWG. E12
T-15	75	3	480	208Y/120	100A, 3∅, 3W	(8)#4/0 & (2)#2G. - 3½"C	1/0	EMERGENCY PWR. *
T-16	75	3	480	208Y/120	100A, 3∅, 3W	(8)#4/0 & (2)#2G. - 3½"C	1/0	EMERGENCY PWR. *
T-1	1000	3	13.8KV	480Y/277	#1/0 15KV CABLE	1600A. BUS DUCT	4/0	SEE DWG. E-12
T-2	1000	3	13.8KV	480Y/277	#1/0 15KV CABLE	1600A. BUS DUCT	4/0	SEE DWG. E-12
T-3	15	1	480	120/240	30A, 1∅, 2W	60A, 1∅, 3W	-	SEE DWG. E-12

◉ SEE "FEEDER SCHEDULE" ON DWG. E-12 FOR CONVERSION OF AMPERE RATED FEEDERS TO CONDUIT AND WIRE SIZE.

* MAX SECONDARY FEEDER LENGTH 25'-0"

NOTE:
1) SEE "FEEDER SCHEDULE" ON DWG. E-12 FOR CONDUIT / WIRING SIZES REQUIRED FOR FEEDER SIZES INDICATED.
2) SEE "MOTOR CONTROL CENTER SCHEDULE" ON DWG. E-32 FOR DISCONNECT, STARTER, FEEDER, LOCAL DISC. AND REFFERENCE TO ELEMENTARY DIAGRAMS FOR EACH MCC FEEDER.

ALL CONDUCTORS SHALL BE COPPER EXCEPT WHERE DESIGNATED TO BE ALUMINUM

Materials, installation, identification and testing shall conform to applicable sections of Martin Marietta Energy Systems, Inc. Technical Specifications E-2.1, "Electrical Construction."

CIRCLED AREAS INDICATE WORK TO BE PERFORMED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

THIS DOCUMENT CONTROLLED BY CHANGE CONTROL SYSTEM 3
ENGINEERING PROCEDURE EP-C-18

REV	DESCRIPTION	BY	CHK	SECT	DEPT	DATE
A	RELOCATED TWCP-1 & TWCP-2 TO MCC-EMG-1	LM				

MARTIN MARIETTA ENERGY SYSTEMS, INC. — REVISION

SQUAD CHECK: PE CA EC EE EM IE M PD SE XAD — APPROVALS: OPERATOR DOE

REFER TO SITE LOCATION DRAWING C.1 (OPERATING CONTRACTOR NO. C3E-21321-A001) FOR CORRELATION OF AE DRAWING NUMBERS TO OPERATING CONTRACTOR DRAWING NUMBERS

REV. NO.	ISSUE OR REVISION - PURPOSE	INITIALS AND DATE
1	REVISED TO AS BUILT 9/30/87	EFO
0	ISSUED FOR CONSTRUCTION	JDK JAM WCG

WORK ORDER NO. K-7062A
PROCUREMENT BY FPPC
INSTALLATION BY FPPC

UNITED STATES DEPARTMENT OF ENERGY

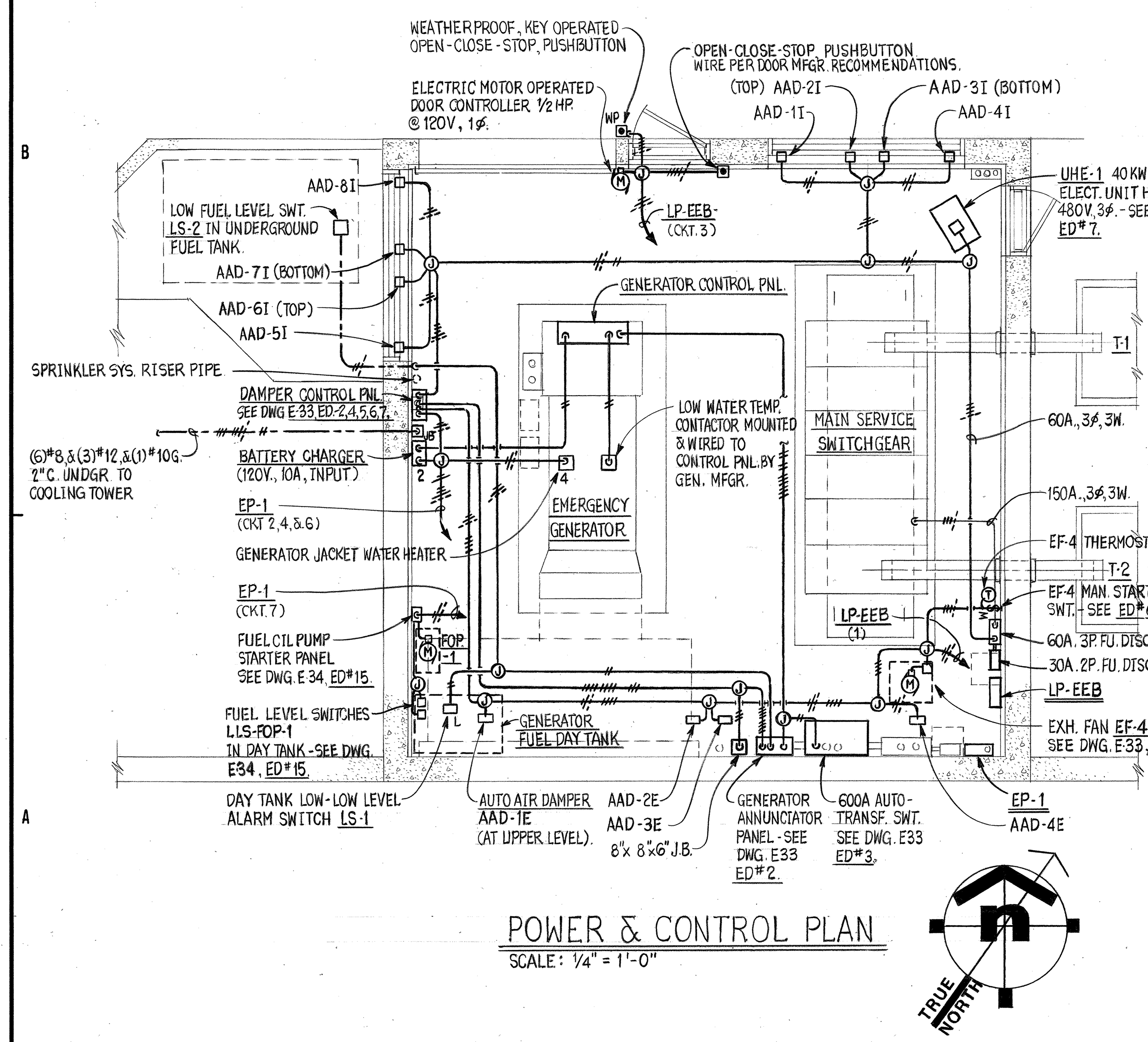
DRS — Deeter Ritchey Sippel Architects/Planners, Four Gateway Center, Pittsburgh, PA 15222
DOE CONTRACT NO. DE-AC05-84OR21361 — A-E NO. 1494

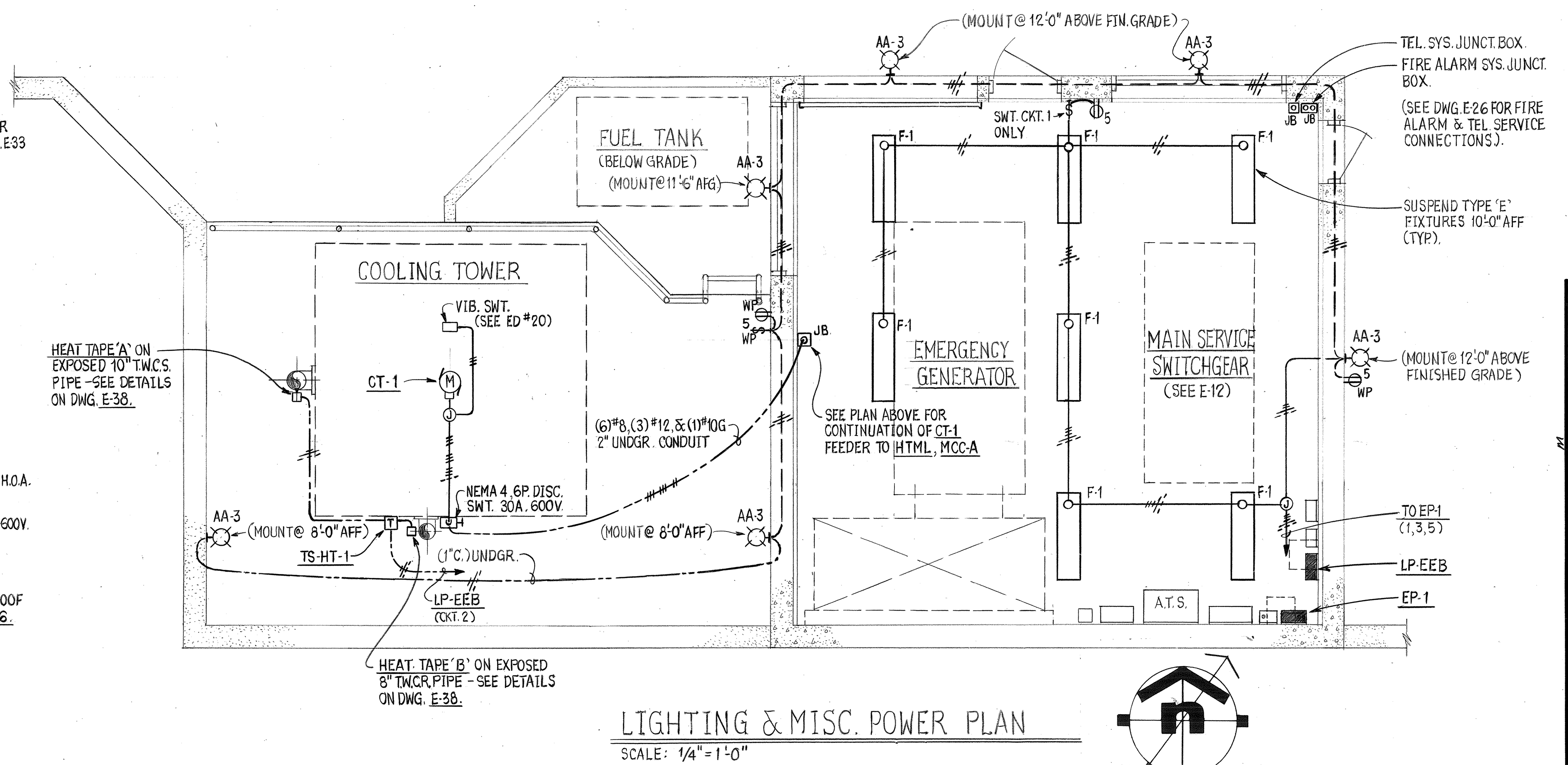
HIGH TEMPERATURE MATERIALS LABORATORY
OAK RIDGE NATIONAL LABORATORY
ELECTRICAL
SINGLE LINE DIAGRAM - HTML BUILDING

HTML-SINGLE LINE DIAG
DRAWN BY E.F.O. 7-30-84 — CHECKED BY T.E.K. 7-30-84 — CHECKED BY JHKY 7-30-84
PLANT X-10 — BLDG 4515 — SCALE NONE
SUBMITTED FOR APPROVAL J.D. KLING 9-18-84 — APPROVAL RECOMMENDED J.A. MURRAY 9-18-84 — DRAWING APPROVED W.C. GILBERT 9-18-84

A. M. Kinney, Inc.

DRAWING NO. E-14 — E3E-21321-D011 — REV. A





REFER TO SITE LOCATION DRAWING C.1 (OPERATING CONTRACTOR NO. C3E-21321-A001) FOR CORRELATION OF AE DRAWING NUMBERS TO OPERATING CONTRACTOR DRAWING NUMBERS

GRAPHIC SCALE: 1/4" = 1'-0" FEET 0 1 2 3 4 5 6 7 8 9 10 11
GRAPHIC SCALE: 1/2" = 1'-0" FEET 1 0 1 2 3 4 5
GRAPHIC SCALE: 1" = 1'-0" FEET 1 0 1 2

REV. NO.	ISSUE OR REVISION - PURPOSE	A-E	OPERATOR	DOE
1	REVISED TO AS BUILT 9/30/87	EFO		
0	ISSUED FOR CONSTRUCTION	JDK	JAM	WCG

SQUAD CHECK: A GKC; CA PAC; EC JES; EE TEK, JL; EM JES; IE —; M —; PD —; SE JEH; XAD —

WORK ORDER NO. K-7062A

SECOND NO. ACCOUNT

PROCUREMENT BY FPPC

INSTALLATION BY FPPC

UNITED STATES DEPARTMENT OF ENERGY

DRS Deeter Ritchey Sippel Architects/Planners Four Gateway Center Pittsburgh, PA 15222

DOE CONTRACT NO. DE-AC05-840R21361 A-E NO. 1494

HIGH TEMPERATURE MATERIALS LABORATORY
OAK RIDGE NATIONAL LABORATORY

ELECTRICAL
ELECTRICAL EQUIPMENT BUILDING
PLANS & DETAILS

ELEC EQ BLDG-PLANS & DET

WILLIAM H. SIPPEL, JR. REGISTERED ARCHITECT AGRICULTURE COMMERCE No. 016547 STATE OF TENNESSEE

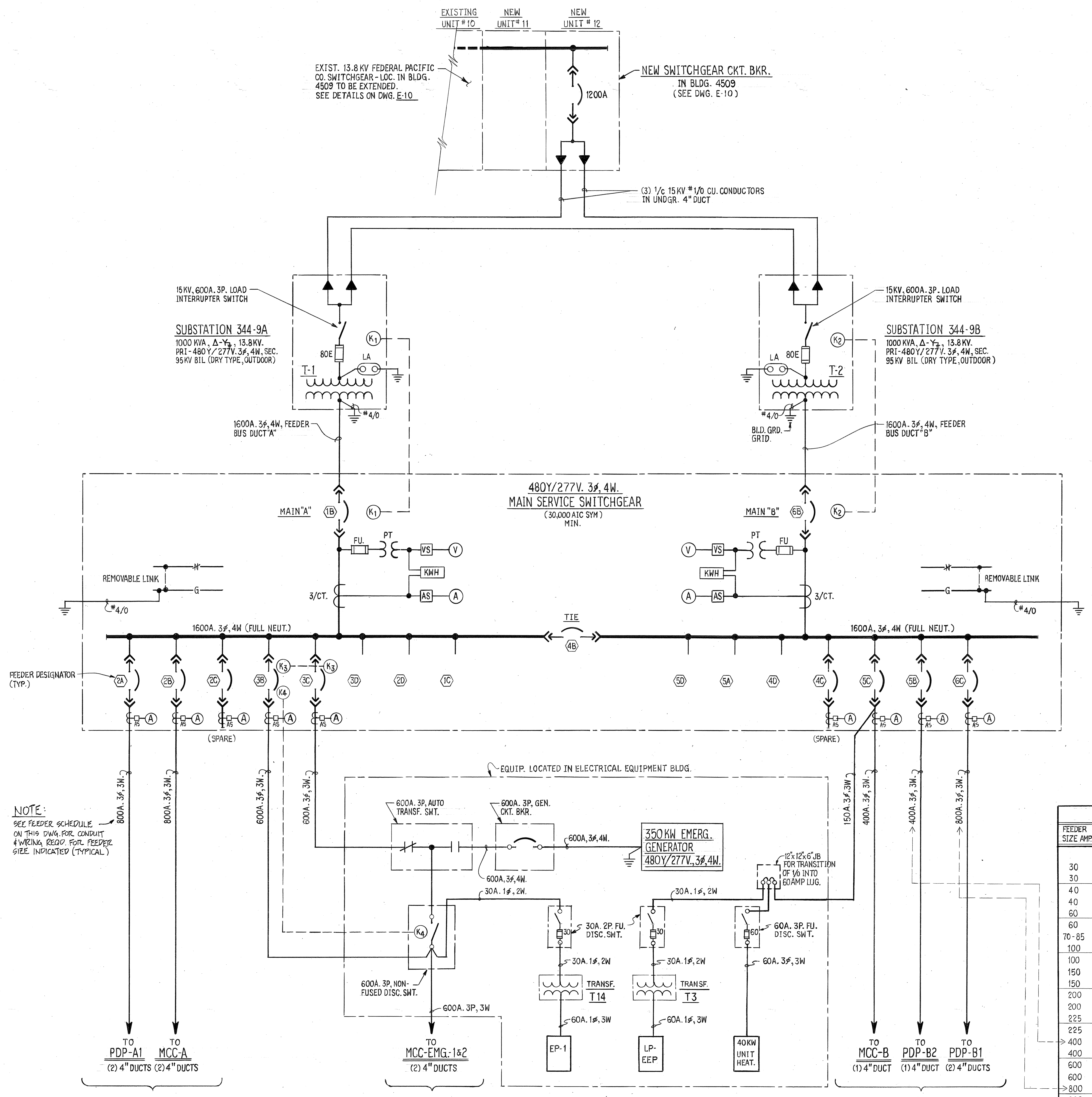
DRAWN BY	DATE	DESIGNED AND CHECKED BY	DATE	CHECKED BY	DATE
E.F.O.	7-30-84	T.E.K.	7-30-84	JHKY	7-30-84

PLANT	BLDG	FLOOR	SCALE	1	48	49	50	TYPE	CLASS
X-10	4514	1	AS NOTED	3	E	E	K	P	U

SUBMITTED FOR APPROVAL: J. D. KLING 9-18-84 (A-E, DATE)
APPROVAL RECOMMENDED: J. A. MURRAY 9-18-84 (OPERATING CONTRACTOR, DATE)
DRAWING APPROVED: W. C. GILBERT 9-18-84 (DOE, DATE)

A. M. Kinney, Inc.

DRAWING NO. E-11 E3E-21326-D001 REV. NO. 1

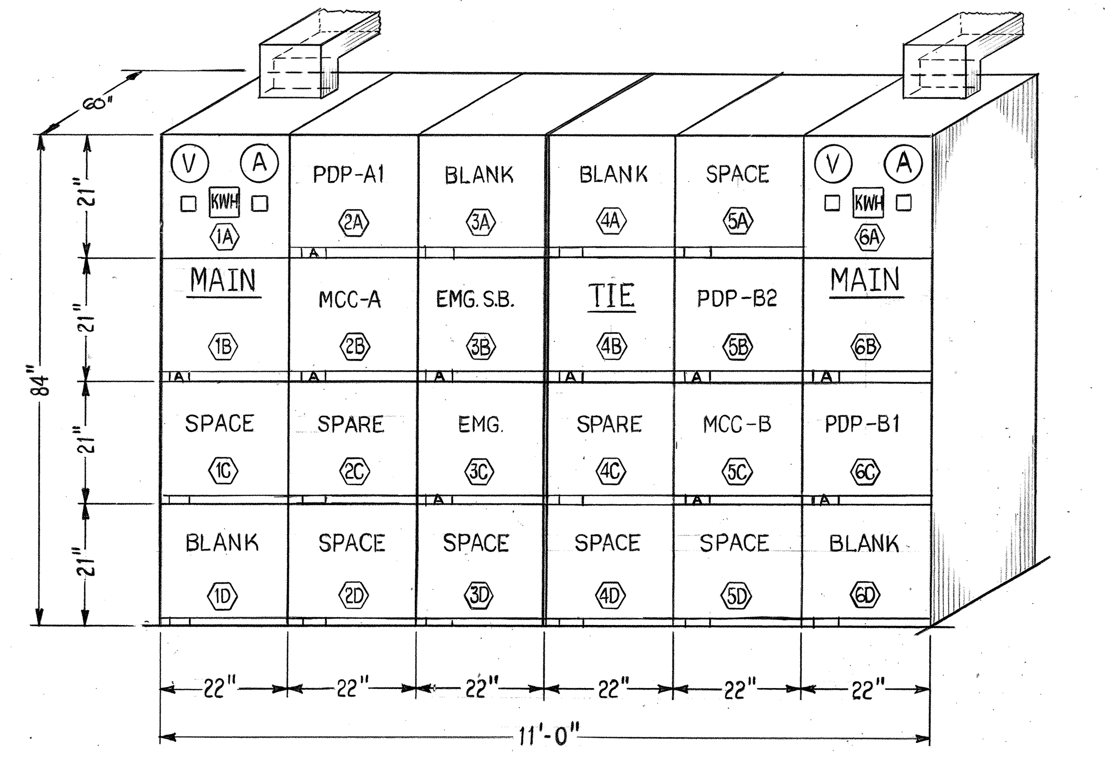


SINGLE LINE DIAGRAM
ELECTRICAL EQUIPMENT BUILDING

MAIN SERVICE SWITCHGEAR - CIRCUIT BREAKER SCHEDULE

BREAKER Nº	LOAD SERVED	FRAME SIZE AMP.	(X) TAPPED SENSOR CURRENT RATING	(C) CURRENT SETTING	TRIP OPERATION	MINIMUM SHORT CIRCUIT KA	Trip Element Adjustment Range: LONG TIME LOW	LONG TIME HI	SHORT TIME LOW	SHORT TIME HI	INSTAN. LOW	INSTAN. HI	GROUND FAULT LOW	GROUND FAULT HI	Trip Element Setting: LONG TIME PICK-UP AMP.	LONG TIME TIME DELAY	SHORT TIME PICK-UP AMP.	SHORT TIME TIME DELAY	INST. PICK-UP AMP.	GRD. FAULT PICK-UP AMP.	GRD. FAULT TIME DELAY	REMARKS
1B	MAIN	1600	1600	1600 1.0x	ELECT.	50	.8c	1.1c	1.5c	9.0c	1.5x	10.0x	.2x	.6x	1.1c	2	3.0c	INT.	—	.6x	INT.	KEY INTERLOCK TO PRIMARY SWT.
2A	PDP-A1	800	800	800 1.0x	MANUAL	30	.8c	1.1c	1.5c	9.0c	1.5x	10.0x	.2x	.6x	1.1c	3	4.0c	MIN.	10x	.6x	MIN.	
2B	MCC-A	800	800	800 1.0x	MANUAL	30	.8c	1.1c	1.5c	9.0c	1.5x	10.0x	.2x	.6x	1.1c	3	4.0c	MIN.	10x	.6x	MIN.	
2C	SPARE	800	800	800 1.0x	MANUAL	30	.8c	1.1c	1.5c	9.0c	1.5x	10.0x	.2x	.6x	—	—	—	—	—	—	—	
3B	EMG. S.B.	800	600	600 1.0x	MANUAL	30	.8c	1.1c	1.5c	9.0c	1.5x	10.0x	.2x	.6x	1.1c	4	5.0c	MIN.	10x	.6x	MIN.	KEY INTERLOCK TO 6A
3C	EMG.	800	600	600 1.0x	MANUAL	30	.8c	1.1c	1.5c	9.0c	1.5x	10.0x	.2x	.6x	1.1c	4	5.0c	MIN.	10x	.6x	MIN.	KEY INTERLOCK TO 5A
3D	SPACE	(800)	—	—	——	—																
2D	SPACE	(800)	—	—	——	—																
1C	SPACE	(800)	—	—	——	—																
4B	TIE	1600	1600	1600 1.0x	ELECT.	50	.8c	1.1c	1.5c	9.0c	1.5x	10.0x	.2x	.6x	1.1c	2	3.0c	INT.	—	.6x	INT.	
6B	MAIN	1600	1600	1600 1.0x	ELECT.	50	.8c	1.1c	1.5c	9.0c	1.5x	10.0x	.2x	.6x	1.1c	2	3.0c	INT.	—	.6x	INT.	KEY INTERLOCK TO PRIMARY SWT.
6C	PDP-B1	800	800	800 1.0x	MANUAL	30	.8c	1.1c	1.5c	9.0c	1.5x	10.0x	.2x	.6x	1.1c	3	4.0c	MIN.	10x	.6x	MIN.	
5B	PDP-B2	800	400	400 1.0x	MANUAL	30	.8c	1.1c	1.5c	9.0c	1.5x	10.0x	.2x	.6x	1.1c	4	9.0c	MIN.	10x	.6x	MIN.	
5C	MCC-B	800	400	400 1.0x	MANUAL	30	.8c	1.1c	1.5c	9.0c	1.5x	10.0x	.2x	.6x	1.1c	4	9.0c	MIN.	10x	.6x	MIN.	
4C	SPARE	800	800	800 1.0x	MANUAL	30	.8c	1.1c	1.5c	9.0c	1.5x	10.0x	.2x	.6x	—	—	—	—	—	—	—	
4D	SPACE	(800)	—	—	——	——																
5A	SPACE	(800)	—	—	——	——																
5D	SPACE	(800)	—	—	——	——																

(X) = SENSOR CURRENT RATING (C) = CURRENT SETTING (ST) = BREAKER SHORT TIME SHORT CIRCUIT RATING



SHORT TIME & GRD FAULT DELAYS:
MIN. = 0.10 SEC.
INT. = 0.22 SEC.
MAX. = 0.36 SEC.

LONG TIME DELAY:
1 = 2.5 SEC.
2 = 5.0 SEC.
3 = 10.0 SEC.
4 = 21.0 SEC.

FEEDER SCHEDULE

FEEDER SIZE AMP.	Ø	W	MAIN CONDUCTOR QUANTITY	MAIN CONDUCTOR SIZE	NEUT. CONDUCTOR QUANTITY	NEUT. CONDUCTOR SIZE	GRD. CONDUCTOR QUANTITY	GRD. CONDUCTOR SIZE	CONDUIT SIZE *
30	3	3	3	10	~	~	1	10	3/4
30	3	4	3	10	1	10	1	10	3/4
40	3	3	3	8	~	~	1	10	3/4
40	3	4	3	8	1	8	1	10	1
60	3	3	3	6	~	~	1	10	1
60	3	4	3	6	1	6	1	10	1 1/2
70-85	3	3	3	4	~	~	1	8	1 1/2
100	3	3	3	2	~	~	1	8	1 1/2
100	3	4	3	2	1	2	1	8	1 1/2
150	3	3	3	1/0	~	~	1	6	1 1/2
150	3	4	3	1/0	1	1/0	1	6	2
200	3	3	3	3/0	~	~	1	6	2
200	3	4	3	3/0	1	3/0	1	6	2 1/2
225	3	3	3	4/0	~	~	1	4	2
225	3	4	3	4/0	1	4/0	1	4	2 1/2
400	3	3	3	500	~	~	1	2	3
400	3	4	3	500	1	500	1	2	3 1/2
600	3	3	(2)x3	350	~	~	(2)x1	1/0	(2) 3
600	3	4	(2)x3	350	(2)x1	350	(2)x1	1/0	(2) 3
800	3	3	(2)x3	500	~	~	(2)x1	1/0	(2) 3
800	3	4	(2)x3	500	(2)x1	500	(2)x1	1/0	(2) 3 1/2
1000	3	4	(3)x3	500	(3)x1	500	(3)x1	3/0	—
30	1	2	2	10	~	~	1	10	3/4
60	1	3	2	6	1	6	1	10	1

* UNLESS OTHERWISE NOTED ON THE DRAWINGS.
(2) INDICATES SETS OF PARALLEL FEEDERS

REFER TO SITE LOCATION DRAWING C.1 (OPERATING CONTRACTOR NO. C3E-21321-A001) FOR CORRELATION OF AE DRAWING NUMBERS TO OPERATING CONTRACTOR DRAWING NUMBERS

			JL							1	REVISED TO AS BUILT 9/30/87	EFO		
GKC	PAC	JES	TEK	JES				JEH		0	ISSUED FOR CONSTRUCTION	JDK	JAM	WCG
A	CA	EC	EE	EM	IE	M	PD	SE	XAD			A-E	OPERATOR	DOE
SQUAD CHECK										REV. NO.	ISSUE OR REVISION - PURPOSE	INITIALS AND DATE		

WORK ORDER NO. K-7062A
SECOND NO. ACCOUNT
PROCUREMENT BY FPPC
INSTALLATION BY FPPC

UNITED STATES
DEPARTMENT OF ENERGY

DRS
Deeter Ritchey Sippel
Architects/Planners
Four Gateway Center
Pittsburgh, PA 15222
DOE CONTRACT NO. DE-AC05-840R21361
A-E NO. 1494

HIGH TEMPERATURE MATERIALS LABORATORY
OAK RIDGE NATIONAL LABORATORY

ELECTRICAL
ELECTRICAL EQUIPMENT BUILDING
SINGLE LINE DIAGRAM

ELEC EQ BLDG-SINGLE LINE

WILLIAM H. SIPPEL, JR. REGISTERED ARCHITECT No. 016547 STATE OF TENNESSEE AGRICULTURE COMMERCE

A. M. Kinney, Inc.

DRAWN BY	DATE	DESIGNED AND CHECKED BY	DATE	CHECKED BY	DATE
E.F.O.	7-30-84	T.E.K.	7-30-84	JHKY	7-30-84

PLANT	BLDG	FLOOR	SCALE	1	48	49	50	TYPE	CLASS
X-10	4514	1	NONE	3	E	P	A	D	U

SUBMITTED FOR APPROVAL	APPROVAL RECOMMENDED	DRAWING APPROVED
J.D. KLING 9-18-84 A-E DATE	J.A. MURRAY 9-18-84 OPERATING CONTRACTOR DATE	W.C. GILBERT 9-18-84 DOE DATE

E-12 DRAWING NO. E3E-21326-D002 REV. NO. 1

ELECTRICAL LEGEND

SYMBOL	DESCRIPTION	MOUNTING HEIGHT
	CONDUIT - CONCEALED IN WALLS OR ABOVE CEILINGS	----
	CONDUIT - CONCEALED IN OR UNDER FLOOR SLAB OR UNDERGROUND	----
	CONDUIT - EXPOSED ON WALLS OR CEILING	----
	CONDUIT - FLEXIBLE METAL OR LIQUID TIGHT AS SPECIFIED	----
	CONDUIT - HOMERUN	----
T	CONDUIT - TELEPHONE-1" MINIMUM-ROUTE TO NEAREST TELEPHONE BACKBD	----
	CONDUIT - SHOWN TURNING UP	----
	CONDUIT - SHOWN TURNING DOWN	----
	CONDUIT - CAPPED FOR FUTURE EXTENSION	----
	CONDUCTOR HASH MARKS - LARGE HASH MARK(S) INDICATES NUMBER OF NEUTRAL CONDUCTORS, SMALL HASH MARK(S) INDICATES NUMBER OF HOT CONDUCTORS, GROUND CONDUCTORS NOT ILLUSTRATED BUT REQUIRED.	----
J J	JUNCTION BOX	----
PB	PULL BOX	----
J	JUNCTION BOX WITH FLEXIBLE CONNECTION TO EQUIPMENT	----
	PANELBOARD/DISTRIBUTION PANELBOARD - SEE PANELBOARD SCHEDULE	6'-0" TO TOP
	TRANSFORMER-DRY TYPE - SEE TRANSFORMER SCHEDULE	----
	DISCONNECT SWITCH - HEAVY DUTY, FUSIBLE	6'-0" TO TOP
	DISCONNECT SWITCH - HEAVY DUTY, NONFUSIBLE	6'-0" TO TOP
RT	DISCONNECT SWITCH - HEAVY DUTY, FUSIBLE, RAINTIGHT (NEMA 3R)	6'-0" TO TOP
RT	DISCONNECT SWITCH - HEAVY DUTY, NONFUSIBLE, RAINTIGHT (NEMA 3R)	6'-0" TO TOP
	MOTOR STARTER - COMBINATION MOTOR STARTER/DISCONNECT SWITCH	6'-0" TO TOP
	MOTOR STARTER - MAGNETIC	----
3	MOTOR WITH APPROXIMATE HORSEPOWER INDICATED	----
	RECEPTACLE - DUPLEX, 20A, 125V., 2P, 3W (NEMA 5-20R)	18" AFF ℄
	RECEPTACLE - DUPLEX - MOUNTED 6" ABOVE COUNTER TOP	6" ABC ℄
GFI	RECEPTACLE - DUPLEX - GROUND FAULT INTERRUPTER TYPE	18" AFF ℄
	GROUNDING - CONDUCTOR CONNECTION	----
	GROUNDING - 3/4" x 10'-0" COPPER ROD	----
	GROUNDING - INDICATES EQUIPMENT GROUNDING REQUIRED	----
A	FIXTURE - RECESSED, SURFACE OR PENDANT MOUNTED - FLUORESCENT - LETTER INDICATES FIXTURE TYPE - SEE FIXTURE SCHEDULE	----
C	FIXTURE - SURFACE MOUNTED - FLUORESCENT STRIP - LETTER INDICATES FIXTURE TYPE - SEE FIXTURE SCHEDULE	----
D	FIXTURE - RECESSED, SURFACE OR PENDANT MOUNTED: INCANDESCENT, HID, OR FLUORESCENT - LETTER INDICATES FIXTURE TYPE - SEE FIXTURE SCHEDULE	----
E	FIXTURE - WALL MOUNTED INCANDESCENT, HID OR FLUORESCENT - LETTER INDICATES FIXTURE TYPE - SEE FIXTURE SCHEDULE	----
L M	FIXTURE - RECESSED, SURFACE, WALL OR PENDANT MOUNTED - FLUORESCENT - CONNECTED TO EMERGENCY GENERATOR CIRCUIT - LETTER INDICATES FIXTURE TYPE - SEE FIXTURE SCHEDULE	----
"D" "E"	FIXTURE - RECESSED, SURFACE, WALL OR PENDANT MOUNTED - INCANDESCENT OR FLUORESCENT - CONNECTED TO EMERGENCY GENERATOR CIRCUIT - LETTER INDICATES FIXTURE TYPE - SEE FIXTURE SCHEDULE	----
	COMBINATION TELEPHONE/DATA - 4" SQ BOX WITH SINGLE GANG PLASTER RING. ROUTE 1" CONDUIT FROM OUTLET TO COMMUNICATIONS BACKBOARD.	18" AFF ℄
FACP	FIRE ALARM - CONTROL PANEL. PROVIDED BY COMPANY, INSTALLED BY SELLER	6'-0" TO TOP
F	FIRE ALARM - ADDRESSABLE MANUAL PULL STATION. PROVIDED BY COMPANY, INSTALLED BY SELLER	48" AFF ℄
SD	FIRE ALARM - ADDRESSABLE AREA SMOKE DETECTOR CEILING MOUNTED. PROVIDED BY COMPANY, INSTALLED BY SELLER	----
DSD	FIRE ALARM - ADDRESSABLE DUCT SMOKE DETECTOR FURNISHED AND CONNECTED BY ELECTRICAL CONTRACTOR. INSTALLED BY MECHANICAL CONTRACTOR. PROVIDED BY COMPANY, INSTALLED BY SELLER	----
L	FIRE ALARM - COMBINATION HORN AND FLASHING STROBE LIGHT. PROVIDED BY COMPANY, INSTALLED BY SELLER	7'-0" AFF ℄
L	FIRE ALARM - FLASHING STROBE LIGHT. PROVIDED BY COMPANY, INSTALLED BY SELLER	7'-0" AFF ℄
FS	FIRE ALARM - ADDRESSABLE SPRINKLER WATER FLOW SWITCH. PROVIDED BY COMPANY, INSTALLED BY SELLER	----
TS	FIRE ALARM - ADDRESSABLE SPRINKLER VALVE TAMPER SWITCH. PROVIDED BY COMPANY, INSTALLED BY SELLER	----
PIV	FIRE ALARM - SPRINKLER POST INDICATOR VALVE (TAMPER SWITCH). PROVIDED BY COMPANY, INSTALLED BY SELLER	----
MM	FIRE ALARM - MONITOR MODULE. PROVIDED BY COMPANY, INSTALLED BY SELLER	----
CM	FIRE ALARM - CONTROL MODULE. PROVIDED BY COMPANY, INSTALLED BY SELLER	----
PA	PUBLIC ADDRESS OUTLET BOX - EQUIPMENT AND WIRING BY COMPANY	7'-0" AFF ℄
CK	CARD READER - PROVIDED BY COMPANY, CONDUIT BY SELLER	----
DS	SECURITY DOOR SWITCH	----
AFG	ABOVE FINISHED GRADE	----
AFF	ABOVE FINISHED FLOOR	----
AHU	AIR HANDLING UNIT	----
EF	EXHAUST FAN - SEE MECHANICAL DRAWINGS	----
GFI	GROUND FAULT INTERRUPTER	----
GRD/GND	GROUND	----
MTD	MOUNTED	----
NTS	NOT TO SCALE	----
PNLBD	PANELBOARD	----
WH	WATER HEATER - SEE MECHANICAL DRAWINGS	----
S	SWITCH - SINGLE POLE, 20A., 120/277V.	48" AFF ℄
S_3	SWITCH - THREE WAY, 20A., 120/277V.	48" AFF ℄
$^{b}S^{c}_{a}$	SWITCH - SUBLETTERS DENOTE SWITCHING CIRCUIT CONTROLLED	48" AFF ℄
C F, D, W, W S	FIXTURE - EXIT SIGN - CONNECTED TO EMERGENCY GENERATOR CIRCUIT, UNIVERSAL MOUNT, WITH DIRECTIONAL ARROWS. - LETTER INDICATES MOUNTING W-WALL, C-CEILING, S-SINGLE FACE, D-DOUBLE FACE, P-PENDANT, F-FLASHING LIGHT IN EMERGENCY MODE. SEE FIXTURE SCHEDULE	7'-6" AFF ℄ FOR WALL MTD SIGN

LEGEND NOTES:

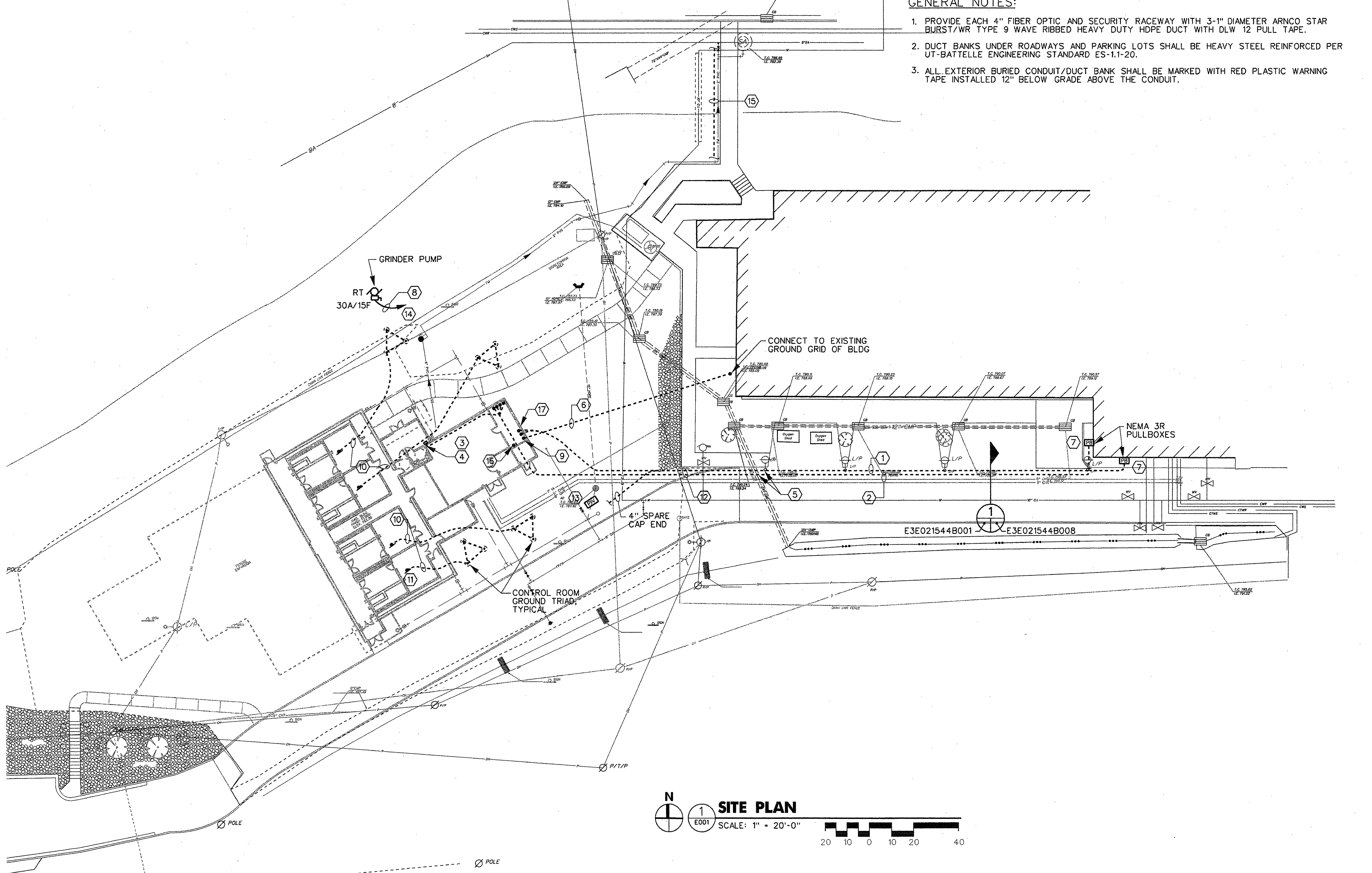
1. MOUNTING HEIGHTS ARE TO CENTERLINES & TYPICAL UNLESS OTHERWISE NOTED ON PLANS OR REQUIRED BY ACTUAL FURNISHINGS & INSTALLATIONS.
2. ABBREVIATIONS MAY BE SHOWN ADJACENT TO EQUIPMENT/DEVICES AND OR IN RACEWAY ROUTINGS.
3. DISCONNECTS SHALL BE NEMA 1 (INDOORS) OR NEMA 3R (OUTDOORS).
4. ENCLOSED CIRCUIT BREAKERS, FUSED & NON FUSED DISCONNECT SWITCHES, MOTOR STARTERS, AND OTHER MANUAL & AUTOMATIC OPERATORS SHALL BE MOUNTED WITH TOP 6'-0" AFF/AFG.

KEYED NOTES:

1. CONCRETE ENCASED ELECTRICAL POWER DUCT BANK. THE ELECTRICAL POWER DUCT BANK SHALL CONSIST OF 1-4"C (NORMAL POWER), 1-4"C (FUTURE CLEAN POWER), 1-1½"C (EMERGENCY POWER), AND 1-4"C (SPARE).
2. CONCRETE ENCASED COMMUNICATION DUCT BANK. THE COMMUNICATION DUCT BANK SHALL CONSIST OF 1-4"C FOR TELEPHONE, 1-4"C (FIBER OPTIC-EQUIPPED WITH INNER DUCT), 1-4"C (SECURITY-EQUIPPED WITH INNER DUCT AND 1-BELDEN #9842 SECURITY CABLE), AND 1-1½"C (FIRE ALARM-4/C#12 IMSA 19-1).
3. ROUTE FIRE ALARM RACEWAY TO FIRE ALARM MASTER BOX.
4. TERMINATE FIRE ALARM RACEWAY AND CONDUCTORS IN FIRE ALARM MASTER BOX.
5. OFFSET UNDER 24" CMP STORM WATER PIPE.
6. #4/0 INSULATED COPPER GROUND CABLE FROM MAIN ELECTRICAL ROOM GROUND BUS.
7. SEE DETAIL #3 ON DRAWING E3E021544B008 FOR CONTINUATION.
8. THE GRINDER PUMP FEEDER SHALL BE ENCASED IN CONCRETE PER UT BATTELLE ENGINEERING STANDARD ES-1.1-20.
9. CONNECT TO MAIN GROUND BUS, SEE DETAIL #5 ON DRAWING E3E021544B008.
10. SEE DRAWING E3E021544B002 FOR CONTINUATION.
11. CONTROL ROOM GROUND BAR, SEE DETAIL #4 ON DRAWING E3E021544B008.
12. THE SELLER SHALL BE RESPONSIBLE FOR ROUTING NEW DUCT BANKS AROUND AND UNDER ANY EXISTING UTILITY LINES AND OTHER OBSTRUCTIONS.
13. FIRE ALARM P.I.V., SEE DRAWING E3E021544B003.
14. ¾" CONDUIT WITH 3#10 AND 1#10 GROUND TO PANEL "A".
15. REMOVE EXISTING CONDUIT, SEE DETAIL #4 ON DRAWING C3E021544B108.
16. STUB- UP CONDUIT AT SECURITY DOOR CONTROLLER.
17. SEE DETAIL #1 ON DWG E3E021544B007.

GENERAL NOTES:

1. PROVIDE EACH 4" FIBER OPTIC AND SECURITY RACEWAY WITH 3-1" DIAMETER ARNCO STAR BURST/WR TYPE 9 WAVE RIBBED HEAVY DUTY HDPE DUCT WITH DLW 12 PULL TAPE.
2. DUCT BANKS UNDER ROADWAYS AND PARKING LOTS SHALL BE HEAVY STEEL REINFORCED PER UT-BATTELLE ENGINEERING STANDARD ES-1.1-20.
3. ALL EXTERIOR BURIED CONDUIT/DUCT BANK SHALL BE MARKED WITH RED PLASTIC WARNING TAPE INSTALLED 12" BELOW GRADE ABOVE THE CONDUIT.



N

1 E001 **SITE PLAN**
SCALE: 1" = 20'-0"
20 10 0 10 20 40

SECTION AND DETAIL KEY
NUMBER OF SECTION OR DETAIL
DRAWING ON WHICH SECTION OR DETAIL IS TAKEN
DRAWING ON WHICH SECTION OR DETAIL IS SHOWN

THIS DOCUMENT CONTROLLED BY
CHANGE CONTROL SYSTEM 3
ENGINEERING PROCEDURE SOP-ENG-D.06

REV	CHANGE TYPE			DESCRIPTION	DSN	CHK	DEPT	DATE	PE	DATE	PJ	DATE	REQ	DATE	RPE	RPE NO	DATE	ST	CV	EC	EE	EM	IE	M	PD	SE	AR	FPE
Ø				CFC 06/19/03																								

REVISION OR ISSUE PURPOSE — REVISION APPROVALS — SQUAD CHECK

RPE		
	DSGN M.J. CARTER	06/19/03
	DRW K.H. BLAIR	06/19/03
	CHKR R.B. STEPHENS	06/19/03
	DEPT	
	PE	
	PJ	
	REQ	
	FMO	
REV. DATE	UT-BATTELLE	

DRAWING APPROVALS

BWSC Barge Waggoner Sumner & Cannon, Inc.
ENGINEERS ARCHITECTS PLANNERS LANDSCAPE ARCHITECTS AND SURVEYORS
First Tennessee Plaza Suite 2400, Knoxville, Tennessee 37929 Phone (865)637-2810 Fax (865)673-8554

UT-BATTELLE
Oak Ridge National Laboratory
managed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC05-00OR22725
UT-BATTELLE, LLC. • Oak Ridge, Tennessee

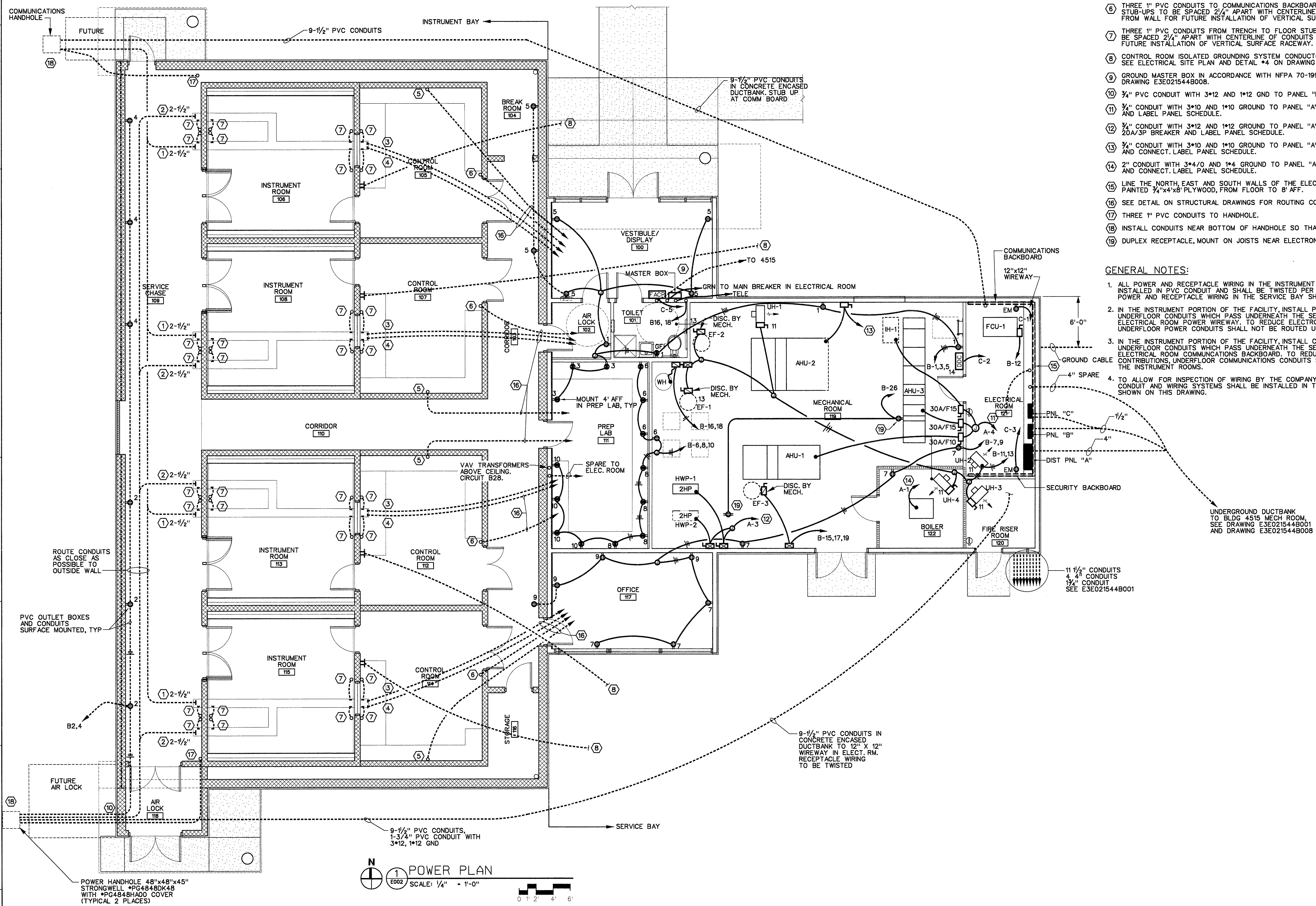
PROJECT NAME:
ADV MATL CHARACT LAB

LEGEND AND SITE PLAN

1	48	49	50	PLANT	BLDG	FL	SH.	OF	TYPE	CLASS
3	E	P	S	X-10	3625		1	1	P	U

51	52	53	DRAWING NUMBER	REV
NC	NA	IN	E3E021544B001	O

E3E021544B001



1 POWER PLAN
E002 SCALE: ¼" = 1'-0"

KEYED NOTES:

1. TWO 1½" PVC CONDUITS TO COMMUNICATIONS HANDHOLE.
2. TWO 1½" PVC CONDUITS TO POWER HANDHOLE
3. TWO 1½" PVC CONDUITS TO COMMUNICATIONS BACKBOARD IN ROOM E121.
4. TWO 1½" PVC CONDUITS TO WIRING TROUGH IN ROOM E121.
5. THREE 1" PVC CONDUITS TO WIRING TROUGH IN ROOM E121. CONDUIT STUB-UPS TO BE SPACED 2¼" APART WITH CENTERLINE OF CONDUITS 1" AWAY FROM WALL FOR FUTURE INSTALLATION OF VERTICAL SURFACE RACEWAY.
6. THREE 1" PVC CONDUITS TO COMMUNICATIONS BACKBOARD IN ROOM E121. CONDUIT STUB-UPS TO BE SPACED 2¼" APART WITH CENTERLINE OF CONDUITS 1" AWAY FROM WALL FOR FUTURE INSTALLATION OF VERTICAL SURFACE RACEWAY.
7. THREE 1" PVC CONDUITS FROM TRENCH TO FLOOR STUB-UP. CONDUIT STUB-UPS TO BE SPACED 2¼" APART WITH CENTERLINE OF CONDUITS 1" AWAY FROM WALL FOR FUTURE INSTALLATION OF VERTICAL SURFACE RACEWAY.
8. CONTROL ROOM ISOLATED GROUNDING SYSTEM CONDUCTORS TO GROUND TRIAD. SEE ELECTRICAL SITE PLAN AND DETAIL #4 ON DRAWING E3E021544B008.
9. GROUND MASTER BOX IN ACCORDANCE WITH NFPA 70-1999. SEE DETAIL #5 ON DRAWING E3E021544B008.
10. ¾" PVC CONDUIT WITH 3#12 AND 1#12 GND TO PANEL "B" CIRCUITS 2 AND 4.
11. ¾" CONDUIT WITH 3#10 AND 1#10 GROUND TO PANEL "A". PROVIDE A 30A/3P BREAKER AND LABEL PANEL SCHEDULE.
12. ¾" CONDUIT WITH 3#12 AND 1#12 GROUND TO PANEL "A". CONNECT TO EXISTING 20A/3P BREAKER AND LABEL PANEL SCHEDULE.
13. ¾" CONDUIT WITH 3#10 AND 1#10 GROUND TO PANEL "A". PROVIDE A 30A/3P BREAKER AND CONNECT. LABEL PANEL SCHEDULE.
14. 2" CONDUIT WITH 3#4/0 AND 1#4 GROUND TO PANEL "A". PROVIDE A 225A/3P BREAKER AND CONNECT. LABEL PANEL SCHEDULE.
15. LINE THE NORTH, EAST AND SOUTH WALLS OF THE ELECTRICAL ROOM WITH FIRE RESISTANT PAINTED ¾"x4'x8' PLYWOOD, FROM FLOOR TO 8' AFF.
16. SEE DETAIL ON STRUCTURAL DRAWINGS FOR ROUTING CONDUITS UNDER WALL.
17. THREE 1" PVC CONDUITS TO HANDHOLE.
18. INSTALL CONDUITS NEAR BOTTOM OF HANDHOLE SO THAT FUTURE CONDUITS CAN BE ADDED.
19. DUPLEX RECEPTACLE, MOUNT ON JOISTS NEAR ELECTRONIC TRAP PRIMER.

GENERAL NOTES:

1. ALL POWER AND RECEPTACLE WIRING IN THE INSTRUMENT BAY OF THE FACILITY SHALL BE INSTALLED IN PVC CONDUIT AND SHALL BE TWISTED PER TECHNICAL SPECIFICATION 16120. ALL POWER AND RECEPTACLE WIRING IN THE SERVICE BAY SHALL BE UN-TWISTED IN EMT CONDUIT.
2. IN THE INSTRUMENT PORTION OF THE FACILITY, INSTALL POWER AND RECEPTACLE WIRING IN UNDERFLOOR CONDUITS WHICH PASS UNDERNEATH THE SERVICE BAY AND TERMINATE IN THE ELECTRICAL ROOM POWER WIREWAY. TO REDUCE ELECTROMAGNETIC FIELD CONTRIBUTIONS, UNDERFLOOR POWER CONDUITS SHALL NOT BE ROUTED UNDERNEATH THE INSTRUMENT ROOMS.
3. IN THE INSTRUMENT PORTION OF THE FACILITY, INSTALL COMMUNICATIONS CONDUITS IN UNDERFLOOR CONDUITS WHICH PASS UNDERNEATH THE SERVICE BAY AND TERMINATE AT THE ELECTRICAL ROOM COMMUNICATIONS BACKBOARD. TO REDUCE ELECTROMAGNETIC FIELD CONTRIBUTIONS, UNDERFLOOR COMMUNICATIONS CONDUITS SHALL NOT BE ROUTED UNDERNEATH THE INSTRUMENT ROOMS.
4. TO ALLOW FOR INSPECTION OF WIRING BY THE COMPANY, POWER AND RECEPTACLE CONDUIT AND WIRING SYSTEMS SHALL BE INSTALLED IN THE EXACT CONFIGURATION AS SHOWN ON THIS DRAWING.

SECTION AND DETAIL KEY: NUMBER OF SECTION OR DETAIL; DRAWING ON WHICH SECTION OR DETAIL IS TAKEN; DRAWING ON WHICH SECTION OR DETAIL IS SHOWN

THIS DOCUMENT CONTROLLED BY
CHANGE CONTROL SYSTEM 3
ENGINEERING PROCEDURE SOP-ENG-D.06

REV	DESCRIPTION	DSN	CHK	DEPT	DATE	PE	DATE	PJ	DATE	REQ	DATE	RPE	RPE NO	DATE
A	AS-BUILT 07/20/04													
Ø	CFC 07/01/03	MJC	RBS	ANW	7/03	LJD	7/03	JAM	7/03	DAB	7/03	MJC	Ø566	7/03

SQUAD CHECK: MEA ANW MJC HLB CER

DSGN	M.J. CARTER	07/01/03
DRW	D.M. CAPPS	07/01/03
CHKR	R.B. STEPHENS	07/01/03
DEPT	A.N. WYLIE	07/01/03
PE	L.J. DEGENHARDT	07/02/03
PJ	J.A. MAYO	07/01/03
REQ	D.A. BLOM	07/01/03
FMO		

DRAWING APPROVALS

BWSC Barge Waggoner Sumner & Cannon, Inc.
ENGINEERS ARCHITECTS PLANNERS LANDSCAPE ARCHITECTS AND SURVEYORS
First Tennessee Plaza Suite 2400, Knoxville, Tennessee 37929 Phone (865)637-2810 Fax (865)673-8554

UT-BATTELLE
Oak Ridge National Laboratory
managed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC05-00OR22725
UT-BATTELLE, LLC, • Oak Ridge, Tennessee

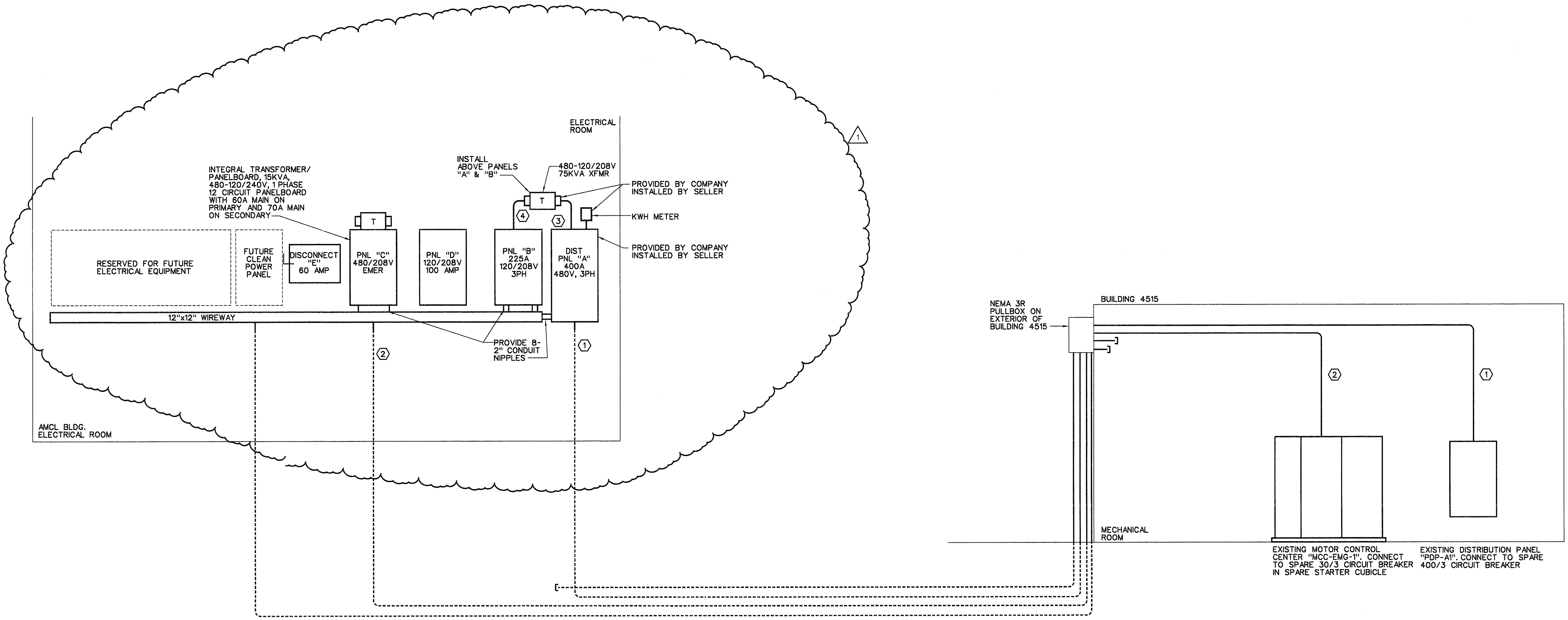
PROJECT NAME:
ADV MATL CHARACT LAB
POWER PLAN

1	48	49	50	PLANT	BLDG	FL	SH.	OF	TYPE	CLASS
3	E	P	H	X-10	3625	1	1	1	P	U

51	52	53	DRAWING NUMBER	REV
NC	NA	IN	E3E021544B002	A

FEEDER SCHEDULE

ITEM NO.	CONDUCTOR WIRE	CONDUCTOR GROUND	CONDUIT SIZE	MAXIMUM FEEDER AMPS	COPPER WIRE
1	3#500 MCM	#2	4"	400	YES
2	2#8	#10	1½"	30	YES
3	3#1/0	#6	1½"	150	YES
4	4#4/0	#4	2½"	230	YES



1 / E007 POWER RISER DIAGRAM
NOT TO SCALE

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THIS DOCUMENT CONTROLLED BY
CHANGE CONTROL SYSTEM 3
ENGINEERING PROCEDURE SOP-ENG-D.06

REV	DESCRIPTION	DSN	CHK	DEPT	DATE	PE	DATE	PJ	DATE	REQ	DATE	RPE	RPE NO	DATE
A	AS-BUILT 07/20/04	—	—											
Ø	CFC 07/01/03	MJC	RBS	ANW	7/03	LJD	7/03	JAM	7/03	DAB	7/03	MJC	0566	7/03

REVISION OR ISSUE PURPOSE — REVISION APPROVALS

SQUAD CHECK: MEA ANW MJC HLB CER (ST CV EC EE EM IE M PD SE AR FPE)

DSGN	M.J. CARTER	07/01/03
DRW	K.H. BLAIR	07/01/03
CHKR	R.B. STEPHENS	07/01/03
DEPT	A.N. WYLIE	07/01/03
PE	L.J. DEGENHARDT	07/02/03
PJ	J.A. MAYO	07/01/03
REQ	D.A. BLOM	07/01/03
FMO		

RPE — REV. DATE — UT-BATTELLE — DRAWING APPROVALS

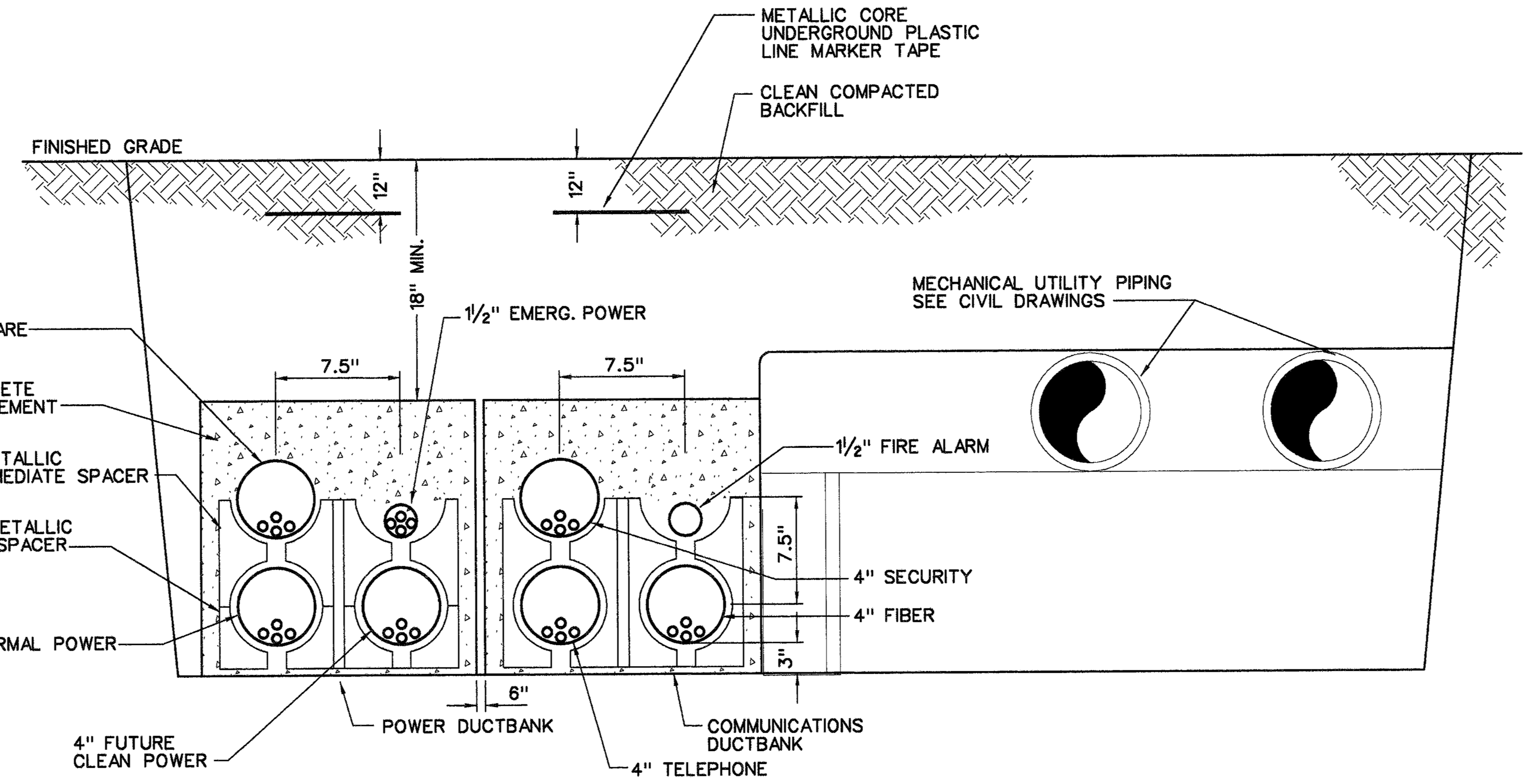
BWSC Barge Waggoner Sumner & Cannon, Inc. — Engineers Architects Planners Landscape Architects and Surveyors — First Tennessee Plaza Suite 2400, Knoxville, Tennessee 37929 Phone (865)637-2810 Fax (865)673-8554

UT-BATTELLE — Oak Ridge National Laboratory managed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC05-00OR22725 UT-BATTELLE, LLC. • Oak Ridge, Tennessee

PROJECT NAME: ADV MATL CHARACT LAB
POWER RISER DIAGRAM

1	48	49	50	PLANT	BLDG	FL	SH.	OF	TYPE	CLASS
3	E	P	A	X-10	3625	X	1	1	P	U

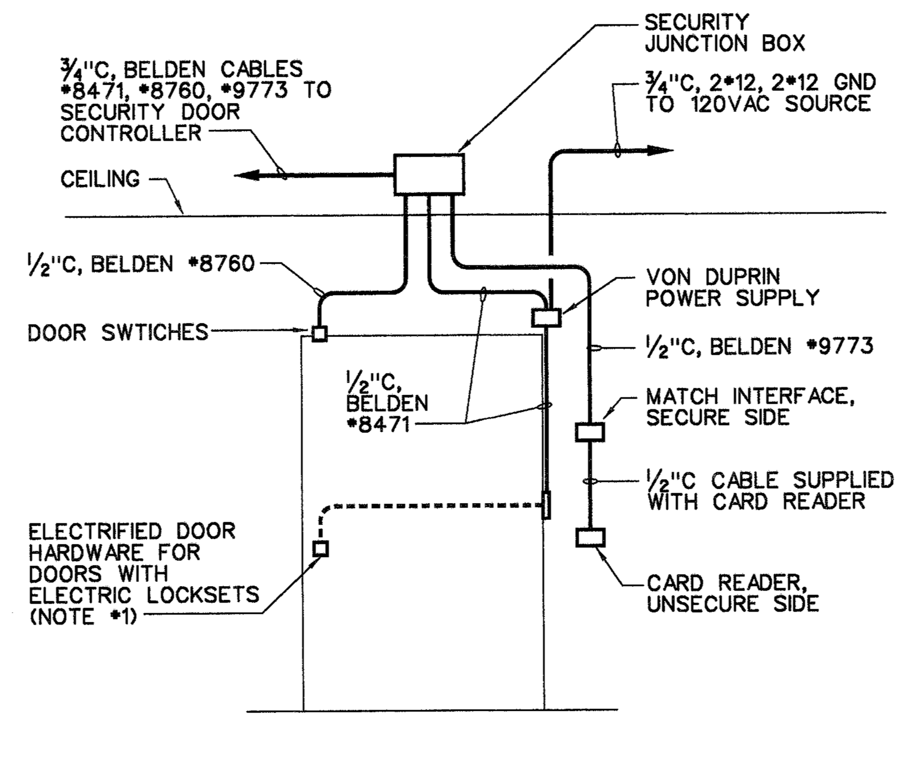
51	52	53	DRAWING NUMBER	REV
NC	NA	IN	E3E021544B007	A



NOTE:

1. DUCT BANKS UNDER ROADWAYS AND PARKING LOTS SHALL BE HEAVY STEEL REINFORCED PER UT BATTELLE ENGINEERING STANDARD ES-1.1-20.

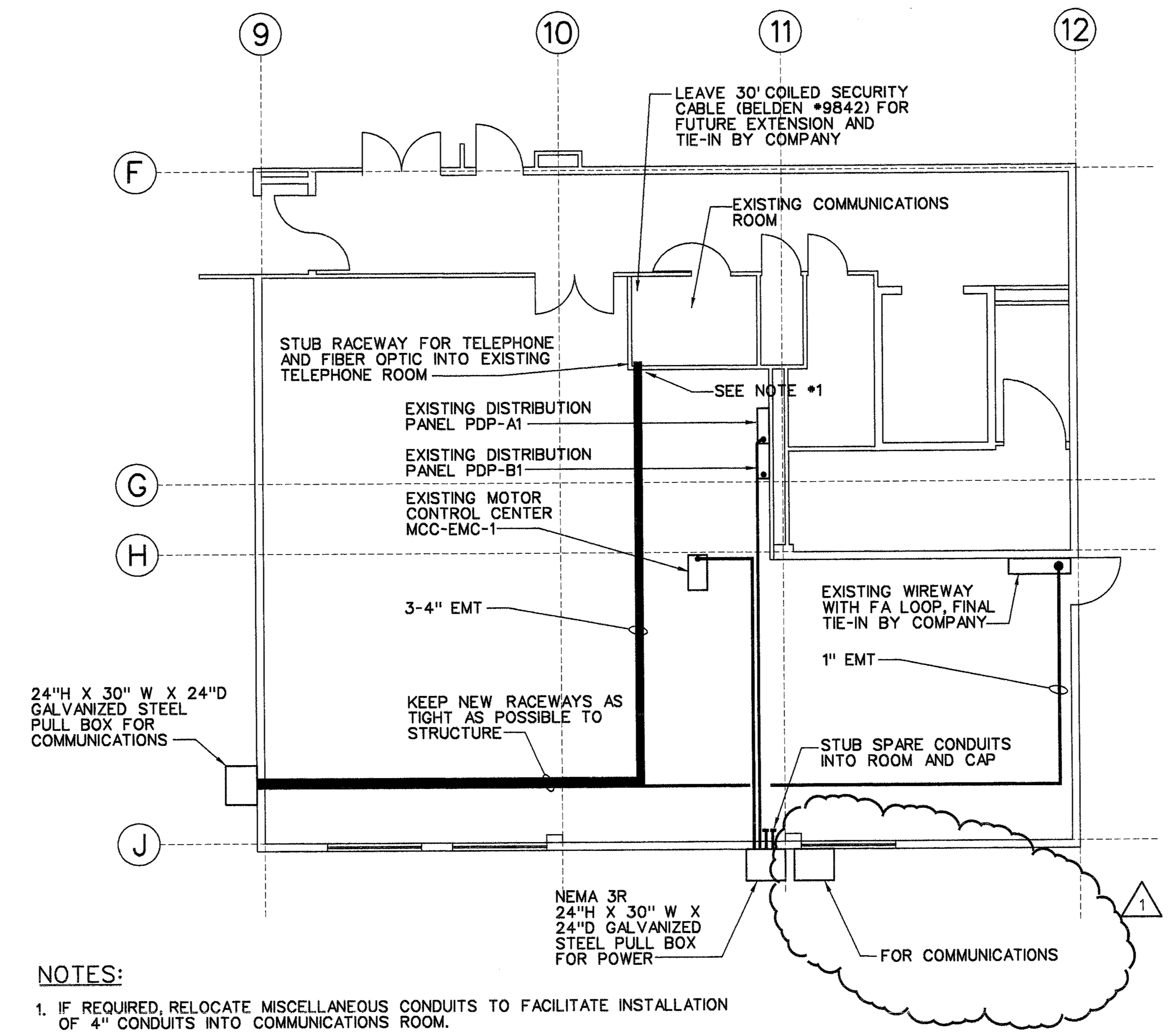
1 E008 CONCRETE-ENCASED DUCTS
NOT TO SCALE



NOTES:

1. COORDINATE WITH DIVISION 8 FOR SPECIFIC LOCATIONS USING ELECTRIC STRIKES.
2. VON DUPRIN POWER SUPPLY, MATCH INTERFACE, CARD READER AND DOOR SWITCHES WILL BE FURNISHED BY COMPANY, INSTALLED BY SELLER. WIRING TERMINATIONS SHALL BE PER COMPANY SUPPLIED WIRING DIAGRAM. ELECTRIC DOOR STRIKES SHALL BE FURNISHED AND INSTALLED BY SELLER. SEE DOOR HARDWARE SCHEDULE.
3. COORDINATE INSTALLATION OF CARD READER AND ASSOCIATED SECURITY EQUIPMENT WITH COMPANY.
4. COMPANY WILL PROGRAM AND START-UP ALL SECURITY EQUIPMENT.

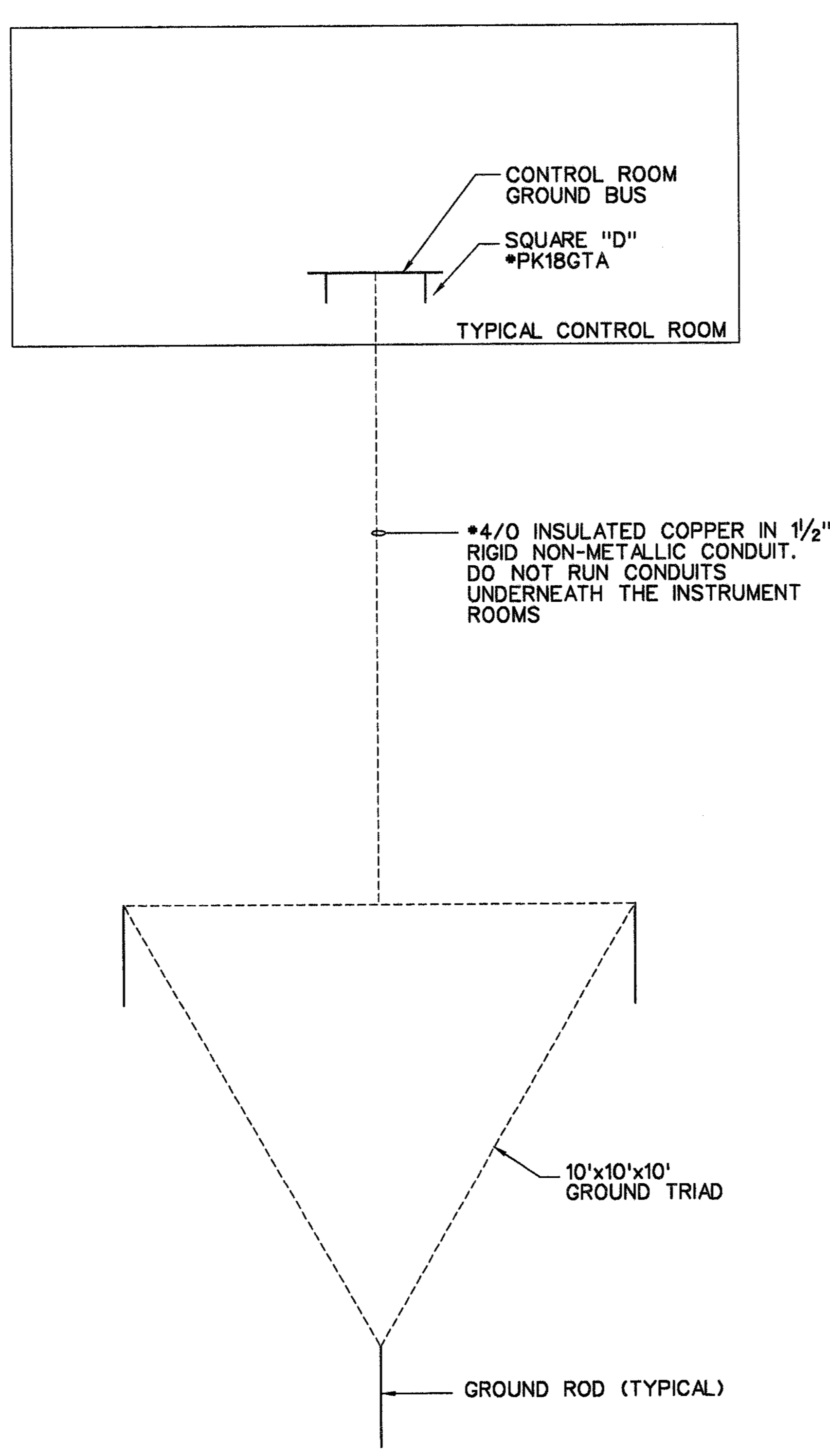
2 E008 SECURED DOORS
NOT TO SCALE



NOTES:

1. IF REQUIRED, RELOCATE MISCELLANEOUS CONDUITS TO FACILITATE INSTALLATION OF 4" CONDUITS INTO COMMUNICATIONS ROOM.

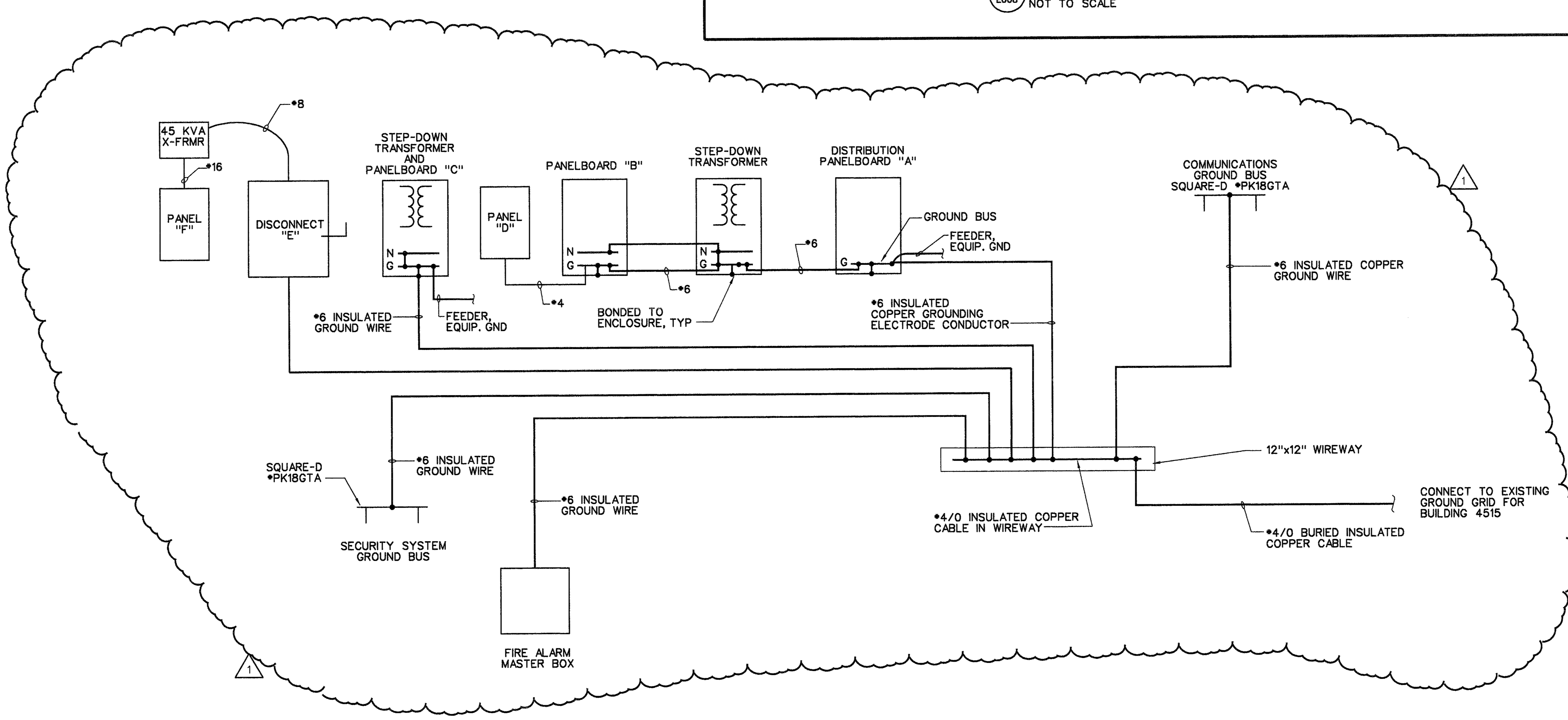
3 E008 EXISTING MECHANICAL EQUIPMENT ROOM IN BLDG 4515
NOT TO SCALE



NOTE:

1. THE CONTROL ROOM GROUNDING SYSTEM SHALL BE A TOTALLY ISOLATED SYSTEM. THERE SHALL BE NO CONNECTIONS TO THE BUILDING GROUNDING SYSTEM, STRUCTURE, ETC.

4 E008 CONTROL ROOM ISOLATED GROUNDING DETAIL
NOT TO SCALE



5 E008 ELECTRICAL GROUNDING ONE-LINE DIAGRAM
NOT TO SCALE

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CHANGE CONTROL SYSTEM 3
ENGINEERING PROCEDURE SDP-ENG-D.06

REV	DESCRIPTION	DSN	CHK	DEPT	DATE	PE	DATE	PJ	DATE	REQ	DATE	RPE	RPE NO	DATE
A	AS-BUILT 07/20/04	—	—	MS	2-05				11/04					
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DRW	D.M. CAPPS 07/01/03
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REQ	D.A. BLOM 07/01/03

BWSC Barge Waggoner Sumner & Cannon, Inc.

UT-BATTELLE
Oak Ridge National Laboratory managed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC05-00OR22725 UT-BATTELLE, LLC • Oak Ridge, Tennessee

PROJECT NAME: ADV MATL CHARACT LAB
DETAILS

PLANT X-10 | BLDG 3625 | FL X | SH. 1 OF 1 | TYPE S | CLASS U
DRAWING NUMBER E3E021544B008 REV A

FIXTURE SCHEDULE

TYPE	MANUFACTURER	CATALOG NUMBER	LAMPS QTY.	LAMPS WATTS	LAMPS TYPE	MOUNTING	REMARKS
A	METALUX	2GC8SR232A125 120EB18	2	32	FLUOR T8	CEILING RECESSED	2x4 TROFFER W/ACRYLIC LENS REGRESSED WHITE STEEL DOOR
B	METALUX	2GC8SR332A125 120EB18	3	32	FLUOR T8	CEILING RECESSED	2x4 TROFFER W/ACRYLIC LENS REGRESSED WHITE STEEL DOOR
C	PASS & SEYMOR	272	1	100	INCAN A19	CEILING SURFACE	KEYLESS PORCELAIN LAMPHOLDER
D	PASS & SEYMOR	272	1	200	INCAN A21	WALL 8'-0" AFF	KEYLESS PORCELAIN LAMPHOLDER
E	LITHONIA	C232120	2	32	FLUOR T8	PENDANT 10'-0" AFF	48" BARE LAMP STRIP W/WIRE GUARD
F	McGRAW EDISON	WL22522120B2	1	250	HPS	WALL 2' BELOW TOP OF PARAPET	MONITOR-4
G	LITHONIA	TWP 200I	1	200	INCAN	WALL TOP 8'-0" AFF	WALL PACK
H	McGRAW EDISON	HPN50120VLLB2	1	50	HPS	WALL TOP 7'-6" AFF	MONITOR-2
⊗	LITHONIA	LQMSW(1,3)R 120 ELN	--	--	LED	SEE LEGEND	EXIT SIGN

SEE LEGEND FOR ADDITIONAL FIXTURE REQUIREMENTS.

PANELBOARD "B" SCHEDULE

VOLTAGE: 120/208 VOLT, 3 PHASE, 4 WIRE
MAINS: 225 AMP, 3 POLE, MAIN BREAKER
MOUNTING: SURFACE
FEEDER: SEE RISER

SQUARE "D"
NQOD
42 POLES

SERVES	CKT BKR	CKT NO.	PHASE - LOADING (KVA) A		B		C		CKT NO.	CKT BKR	SERVES
RECEPTACLES	20/1	1	0.7	0.6					2	20/1	RECEPTACLES
RECEPTACLES	20/1	3			0.6	0.6			4	20/1	RECEPTACLES
RECEPTACLES	20/1	5					0.7	0.7	6	20/1	RECEPTACLES
RECEPTACLES	20/1	7	1.1	0.7					8	20/1	RECEPTACLES
RECEPTACLES	20/1	9			0.7	0.7			10	20/1	RECEPTACLES
UNIT HEATERS	20/1	11					0.3	0.8	12	20/1	FCU-1
EF-1, EF-2	20/1	13	1.0						14	20/1	SPARE
EF-3	20/	15			0.6	1.5			16	20/	WATER HEATER
		17					0.6	1.5	18	/2	
	/3	19	0.6	0.5					20	20/1	EXTERIOR LIGHTS
LIGHTS-SERVICE BAY	20/1	21			1.1	1.8			22	20/1	LIGHTS-INSTR BAY
LIGHTS-INSTR BAY	20/1	23					0.8	1.6	24	20/1	LIGHTS-INSTR BAY
LIGHTS-INSTR BAY	20/1	25	1.6	1.0					26	20/1	TRAP PRIMERS
LIGHTS-INSTR BAY	20/1	27			1.6				28	20/1	SPARE
LIGHTS-INSTR BAY	20/1	29					0.8		30	20/1	SPARE
LIGHTS-INSTR BAY	20/1	31	1.6						32	20/1	PROVISIONS
LIGHTS-INSTR BAY	20/1	33			1.6				34	20/1	PROVISIONS
SPARE	20/1	35							36	20/1	PROVISIONS
SPARE	20/1	37							38	20/1	PROVISIONS
SPARE	20/1	39							40	20/1	PROVISIONS
PROVISIONS	20/1	41							42	20/1	PROVISIONS
MINIMUM INTERRUPTING RATING: 10,000			TOTAL "A" (KVA) 9.4		TOTAL "B" (KVA) 10.8		TOTAL "C" (KVA) 7.8		PANELBOARD TOTAL KVA: 28.0		

PANELBOARD "C" SCHEDULE

VOLTAGE: 120/240 VOLT, 1 PHASE, 3 WIRE
MAINS: 60A PRIMARY, 70A SECONDARY
MOUNTING: SURFACE
FEEDER: SEE RISER

SQUARE "D"
12 POLES

SERVES	CKT BKR	CKT NO.	PHASE - LOADING (KVA) A		B		CKT NO.	CKT BKR	SERVES
RECEPTACLES	20/1	1	1.0	0.5			2	20/1	DDC PANEL
LIGHTS	20/1	3			1.5		4	20/1	SPARE
SECURITY	20/1	5	1.0				6	20/1	SPARE
FACP	20/1	7			0.3		8	20/1	SECURITY
PROVISIONS	20/1	9					10	20/1	PROVISIONS
PROVISIONS	20/1	11					12	20/1	PROVISIONS
MINIMUM INTERRUPTING RATING: 10,000			TOTAL "A" (KVA) 2.5		TOTAL "B" (KVA) 1.8		PANELBOARD TOTAL KVA: 4.3		

DISTRIBUTION PANELBOARD "A" SCHEDULE

480 VOLTS, 400 AMP, 3-PH., 3-W., DELTA CONNECTION

PANELBOARD	CIRCUIT NUMBER IN USE	CIRCUIT NUMBER SPARE	LOAD	CIRCUIT BREAKER	CONDUCTORS CIRCUIT	CONDUCTORS GND.	SERVES
"A" SQUARE "D" ~~1~~	0		218.3 KVA	400/3P			MAIN BREAKER
	~~2~~ 1		150 KVA	225/3P			BOILER 2
	2		28.5 KVA	125/3P			PNL "B" VIA XFMR
	3		5.7 KVA	20/3P			PUMPS HWP-1,HWP-2
	~~3~~ 4		20.0 KVA	30/3P			AHU-1,AHU-3&H-1 3
	~~3~~ 5		17.5 KVA	30/3P			AHU-2 3
	6		5.7 ~~KVA~~	225A/3P			PNL "HA"

~~KEYED NOTES:~~

~~1 DISTRIBUTION PANELBOARD "A" WHICH INCLUDES 400A/3P MAIN BREAKER AND 1-125A, 3P AND 2-20A/3P BRANCH BREAKERS. PANELBOARD AND BREAKERS SHALL BE PROVIDED BY COMPANY, INSTALLED BY SELLER.~~

~~2 225A, 3P BREAKER FOR BOILER SHALL BE PROVIDED AND INSTALLED BY SELLER.~~

~~3 30A/3P BREAKER SHALL BE PROVIDED AND INSTALLED BY SELLER.~~

SECTION AND DETAIL KEY
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THIS DOCUMENT CONTROLLED BY
CHANGE CONTROL SYSTEM 3
ENGINEERING PROCEDURE SOP-ENG-D.06

Ø CFC 06/19/03
REV | CHANGE TYPE | DESCRIPTION — REVISION OR ISSUE PURPOSE | DSN | CHK | DEPT | DATE | PE | DATE | PJ | DATE | REQ | DATE | RPE | RPE NO | DATE — REVISION APPROVALS | ST | CV | EC | EE | EM | IE | M | PD | SE | AR | FPE — SQUAD CHECK

RPE		
	DSGN M.J. CARTER	06/19/03
	DRW K.H. BLAIR	06/19/03
	CHKR R.B. STEPHENS	06/19/03
	DEPT	
	PE	
	PJ	
	REQ	
	FMO	
REV. DATE	UT-BATTELLE	

DRAWING APPROVALS

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ENGINEERS ARCHITECTS PLANNERS LANDSCAPE ARCHITECTS AND SURVEYORS
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UT-BATTELLE, LLC. • Oak Ridge, Tennessee

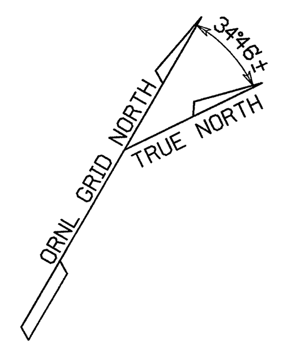
PROJECT NAME:
ADV MATL CHARACT LAB
SCHEDULES

1	48	49	50	PLANT	BLDG	FL	SH.	OF	TYPE	CLASS
3	E	P	S	X-10	3625		1	1	G	U

51	52	53	DRAWING NUMBER	REV
NC	NA	IN	E3E021544B009	0

E3E021544B009

NEXT ASS'Y: FINAL ASS'Y:

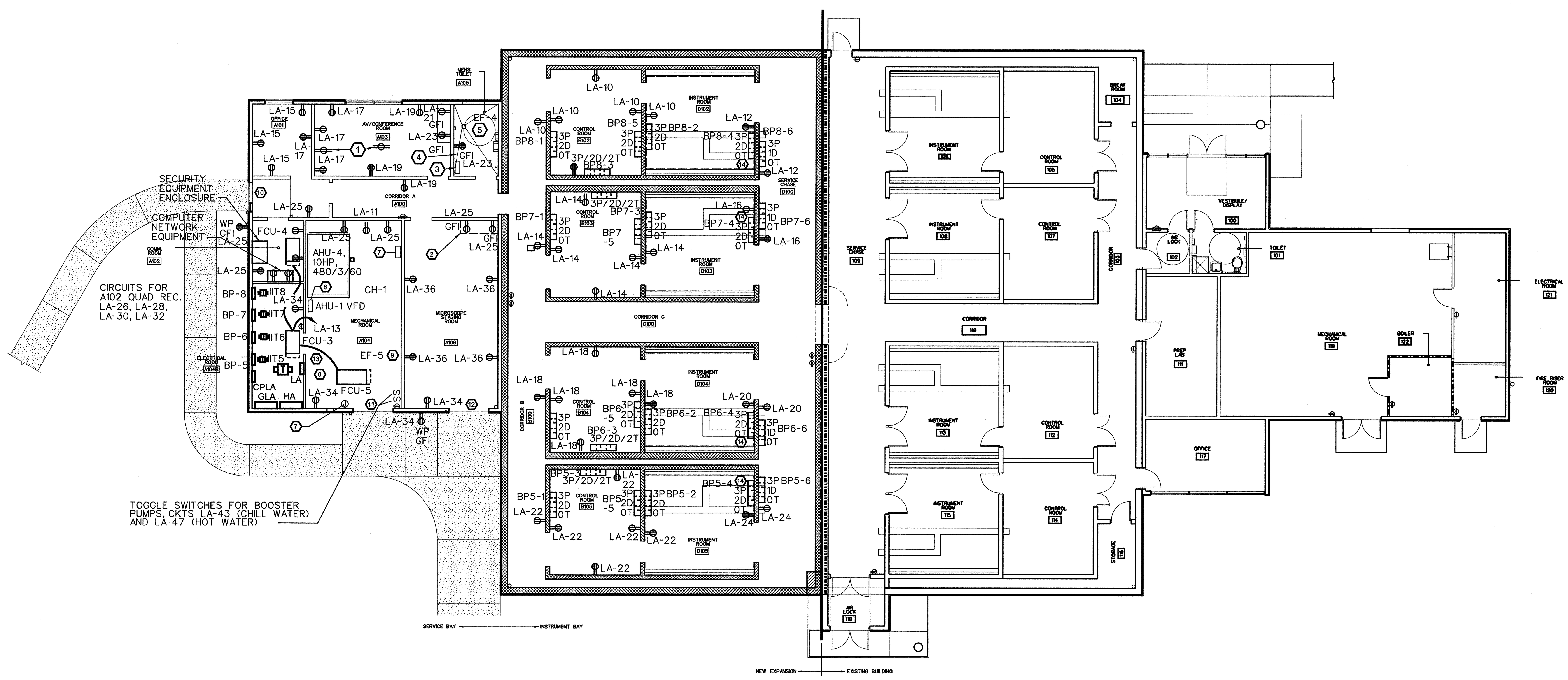


GENERAL NOTES

1. ALL POWER AND RECEPTACLE WIRING IN THE INSTRUMENT BAY OF THE FACILITY (CORRIDOR B, CORRIDOR C, SERVICE CHASE, (4) CONTROL ROOMS AND (4) INSTRUMENT ROOMS) SHALL BE INSTALLED IN PVC CONDUIT AND SHALL BE TWISTED. ALL POWER AND RECEPTACLE WIRING IN THE SERVICE BAY SHALL BE UN-TWISTED IN EMT CONDUIT.
2. IN THE (4) CONTROL ROOMS INSTALL POWER AND RECEPTACLE WIRING IN UNDERFLOOR CONDUITS WHICH PASS UNDERNEATH THE SERVICE BAY AND TERMINATE AT THE WIREMOLD OR RECEPTACLES IN THE CONTROL ROOMS. ROUTE WIREMOLD AROUND THE CONTROL ROOM WALL TO CONNECT WIREMOLD DEVICES. TO REDUCE ELECTROMAGNETIC FIELD CONTRIBUTIONS, UNDERFLOOR POWER CONDUITS (EXCEPT BALANCED POWER CIRCUITS) SHALL NOT BE ROUTED UNDERNEATH THE INSTRUMENT ROOMS.
3. IN THE (4) CONTROL ROOMS INSTALL COMMUNICATIONS CONDUITS IN UNDERFLOOR CONDUITS WHICH PASS UNDERNEATH THE SERVICE BAY AND TERMINATE IN THE COMMUNICATIONS ROOM. TO REDUCE ELECTROMAGNETIC FIELD CONTRIBUTIONS, UNDERFLOOR COMMUNICATIONS CONDUITS (EXCEPT 2 WIREMOLD DATA OUTLETS PER INSTRUMENT ROOM) SHALL NOT BE ROUTED UNDERNEATH THE INSTRUMENT ROOMS.
4. TO ALLOW FOR INSPECTION OF WIRING BY THE COMPANY, POWER AND RECEPTACLE CONDUIT AND WIRING SYSTEMS SHALL BE INSTALLED IN THE EXACT CONFIGURATION AS SHOWN ON THIS DRAWING.
5. USE WIREMOLD PLASTIC RACEWAY FOR WIRING LIGHT SWITCHES AND GENERAL PURPOSE RECEPTACLES IN THE (4) CONTROL ROOMS.
6. USE SURFACE MOUNTED PVC CONDUIT FOR WIRING LIGHT SWITCHES AND GENERAL PURPOSE RECEPTACLES IN THE (4) MICROSCOPE INSTRUMENT ROOMS AND THE SERVICE CORRIDOR.
7. SEE LEGEND NOTES ON DRAWING E3E021544D001 FOR SPECIAL REQUIREMENTS FOR LABELING BALANCED POWER SYSTEMS.
8. MOUNT INSTRUMENT ISOLATION TRANSFORMERS (IIT8, IIT7, IIT6 AND IIT5) ON THE WALL ABOVE THE BALANCED POWER SYSTEMS. SEE RISER DIAGRAM DRAWING E3E021544D009 FOR RELATIVE LOCATIONS OF BALANCED POWER PANELS, INSTRUMENT ISOLATION TRANSFORMERS, GROUNDING BARS AND ASSOCIATED DISCONNECTS.
9. EACH INSTRUMENT ROOM, D102, D103, D104 AND D105 IS TO HAVE A GROUND BAR MOUNTED 18" AFF ADJACENT TO THE SERVICE TRENCH. THE GROUND BAR IS TO BE IDENTICAL TO THE COMMON GROUND BAR IN THE ELECTRICAL ROOM.

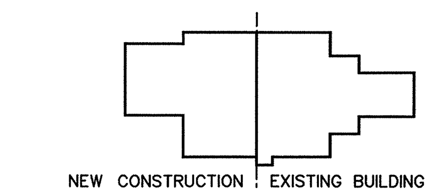
KEYED NOTES

1. DUPLEX OUTLETS (2) ABOVE CEILING FOR AUDIO/VISUAL PROJECTOR AND SCREEN. ALLOW 3 FEET OF FLEX CONDUIT AT EACH LOCATION. 3/4"C., 2*12, 1*12GND. TO CIRCUIT LA-27. SEE DRAWING E3E0215344D006 FOR ASSOCIATED FLOOR BOX POWER CONNECTION.
2. 3/4"C., 2*12, 1*12GND. TO CIRCUIT LA-38 FOR UNDER COUNTER WATER HEATER. MOUNT DUPLEX GFCI RECEPTACLE UNDER COUNTER FOR CONNECTION TO WATER HEATER.
3. 3/4"C., 2*12, 1*12GND. TO CIRCUIT LA-40 FOR WATER HEATER. MOUNT DUPLEX GFCI RECEPTACLE ADJACENT TO WATER HEATER FOR CONNECTION BELOW SINK.
4. 3/4"C., 2*12, 1*12GND. TO CIRCUIT LA-42 FOR SOLENOID FLUSH VALVE POWER SUPPLIES. MOUNT (2) JUNCTION BOXES ABOVE CEILING FOR CONNECTION OF FLUSH VALVE POWER SUPPLIES FOR THE WATER CLOSET AND LAVATORY.
5. 3/4"C., 2*12, 1*12GND. TO CIRCUIT LA-9 CONNECTION OF EF-4. MOUNT DUPLEX RECEPTACLE ABOVE CEILING AND BELOW ROOF FOR CONNECTION OF EXHAUST FAN.
6. AHU-4 VFD IS TO BE SUPPLIED BY AHU-4 MANUFACTURER FOR FIELD MOUNTING AND FIELD WIRING. MOUNT ON WALL AND CONNECT 3/4"C., 3*10, 1*10GND. FROM VFD TO AHU-4 AND FROM VFD TO CIRCUIT HA-19,21,23.
7. CHILLER REFRIGERANT MONITORING SYSTEM CONTROL PANEL WITH WALL MOUNTED HORN/STROBE ADJACENT TO DOOR. CONNECT CONTROL PANEL TO CIRCUIT LA-39 AND TO HORN/STROBE WITH 3/4"C., 2*12, 1*12GND.
8. (4) INSTRUMENT CHILLERS IN THIS AREA. COMBINATION STARTER/DISCONNECTS ON SOUTH WALL. CONNECT INSTRUMENT CHILLER *5 TO GLA-1,3 WITH 3/4"C., 2*12, 1*12GND. CONNECT INSTRUMENT CHILLER *6 TO GLA-5,7 WITH 3/4"C., 2*12, 1*12GND. CONNECT INSTRUMENT CHILLER *7 TO GLA-2,4 WITH 3/4"C., 2*12, 1*12GND. CONNECT INSTRUMENT CHILLER *8 TO GLA-6,8 WITH 3/4"C., 2*12, 1*12GND.
9. EXHAUST FAN EF-5. CONNECT EF-5 TO LA-41 AND TO FIELD WIRED MOTORIZED DAMPER WITH 3/4"C., 2*12, 1*12.
10. POWER FOR CARD READER: 3/4"C., 2*12, 1*12 TO LA-33. SEE DRAWING E3E021544D006 FOR CARD READER INSTALLATION.
11. POWER FOR CARD READER: 3/4"C., 2*12, 1*12 TO LA-35. SEE DRAWING E3E021544D006 FOR CARD READER INSTALLATION.
12. POWER FOR CARD READER: 3/4"C., 2*12, 1*12 TO LA-37. SEE DRAWING E3E021544D006 FOR CARD READER INSTALLATION.
13. POWER FOR P12 ELECTRONIC TRAP PRIMER: 3/4"C., 2*12, 1*12 TO LA-7. SEE DRAWING P3E021544B011 FOR TRAP PRIMER INSTALLATION.
14. BALANCED POWER SYSTEM CIRCUITS FROM THE DUCTBANKS ARE TO BE TURNED UP AT THE WIREMOLD OUTLETS IN SERVICE CHASE D100. THEY ARE TO THEN BE ROUTED BACK BELOW THE SLAB AND TURNED UP AT TWO LOCATIONS IN THE ASSOCIATED INSTRUMENT ROOM. DATA CABLE FROM THE DUCTBANK IS TO BE TURNED UP AT THE WIREMOLD AND SINGLE DROP DATA OUTLETS IN SERVICE CHASE D100. WIREMOLD DATA CABLE CONTINUTATION IS TO THEN BE ROUTED BACK BELOW THE SLAB AND TURNED UP AT TWO LOCATIONS IN THE ASSOCIATED INSTRUMENT ROOM. GENERAL PURPOSE DUPLEX OUTLET RECEPTACLES (CIRCUITS LA-12, 16, 20 AND 24) ARE TO BE TURNED UP FROM THE DUCTBANKS AT THE RECEPTACLE ON THE EAST WALL AND BE CONNECTED WITH PVC CONDUIT AND CONDUCTORS ROUTED AROUND THE INSTRUMENT ROOM WALL.



1 POWER PLAN
SCALE: 1/8" = 1'-0"
E3E021544D003 E3E021544D003

KEYPLAN



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NUMBER OF SECTION OR DETAIL
DRAWING ON WHICH SECTION OR DETAIL IS TAKEN
DRAWING ON WHICH SECTION OR DETAIL IS SHOWN
SECTION AND DETAIL KEY

THIS DOCUMENT CONTROLLED BY
CHANGE CONTROL SYSTEM ______
ENGINEERING PROCEDURE ______

REV	CHANGE TYPE	CHANGE CONTROL SYSTEM	CHANGE REQUEST NUMBER	DESCRIPTION	DSN	DATE	CHK	DATE
1				RECORD DRAWING			CT	4/26/11
Ø	---	---	---	ISSUED - CERTIFIED FOR CONSTRUCTION	EFM	8/28/09	LMS	

REVISION OR ISSUE PURPOSE

PE	DATE	PM	DATE	REQ	DATE	CFM	DATE	RPE	RPE NO	DATE
								MJC		8/28/09

REVISION APPROVALS

ST	CV	EC	EE	EM	IE	M	PD	SE	AR	FPE

INTER-DISCIPLINE CHECK

RPE
REV. DATE

DSGN	M.J. CARTER	08/28/09
DRW	K.H. BLAIR	08/28/09
CHKR	E.F. MEGGS	08/28/09
PE		/ /
PM		/ /
REQ		/ /
CFM		/ /

REVISION Ø APPROVALS DATE

BWSC BARGE WAGGONER SUMNER & CANNON, INC.
10133 Sherrill Blvd., Suite 200, Knoxville, Tennessee 37932 PHONE (865) 637-2810 FAX (865) 673-8554

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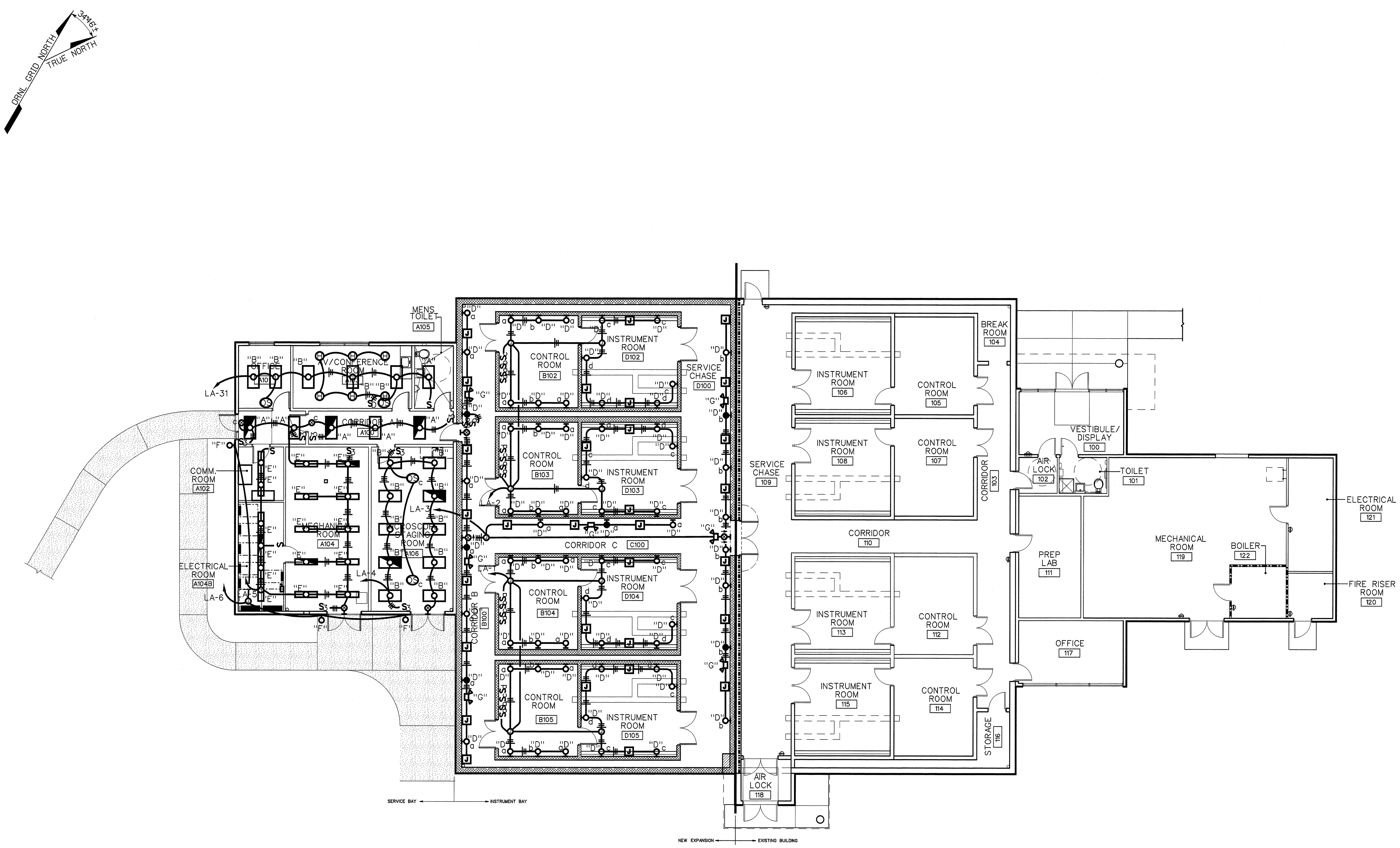
Oak Ridge National Laboratory
managed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-ACØ5-ØØOR22725
UT-BATTELLE, LLC, • Oak Ridge, Tennessee

PROJECT NAME:
ADV MICROSCOPY LAB EXPANSION
POWER PLAN

SITE	BLDG	FL	SH.	OF	
ORNL	3625	1	1	1	UNCLASSIFIED

DRAWING NUMBER E3E021544D003 REV 1

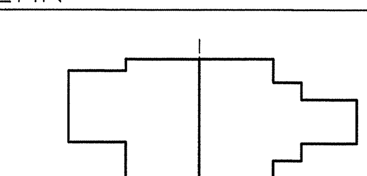


1 LIGHTING PLAN

SCALE: 1/8" = 1'-0"

E3E021544D007 E3E021544D007

KEYPLAN



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SECTION AND DETAIL KEY

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CHANGE CONTROL SYSTEM ________

ENGINEERING PROCEDURE ________

REV	CHANGE TYPE	CHANGE CONTROL SYSTEM	CHANGE REQUEST NUMBER	DESCRIPTION	DSN	DATE	CHK	DATE	PE	DATE	PM	DATE	REQ	DATE	CFM	DATE	RPE	RPE NO	DATE
1				RECORD DRAWING			CT	4/26/11											
Ø	---	---	---	ISSUED - CERTIFIED FOR CONSTRUCTION	EFM	8/28/09	LMS	8/28/09									MJC	105666	8/28/09

REVISION OR ISSUE PURPOSE — REVISION APPROVALS — INTER-DISCIPLINE CHECK: ST CV EC EE EM IE M PD SE AR FPE

RPE		
DSGN	M.J. CARTER	08/28/09
DRW	K.H. BLAIR	08/28/09
CHKR	E.F. MEGGS	08/28/09
PE		/ /
PM		/ /
REQ		/ /
CFM		/ /
REV. / DATE	REVISION Ø APPROVALS	DATE

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PROJECT NAME:
ADV MICROSCOPY LAB EXPANSION

LIGHTING PLAN

SITE	BLDG	FL	SH.	OF	
ORNL	3625	1	1	1	UNCLASSIFIED

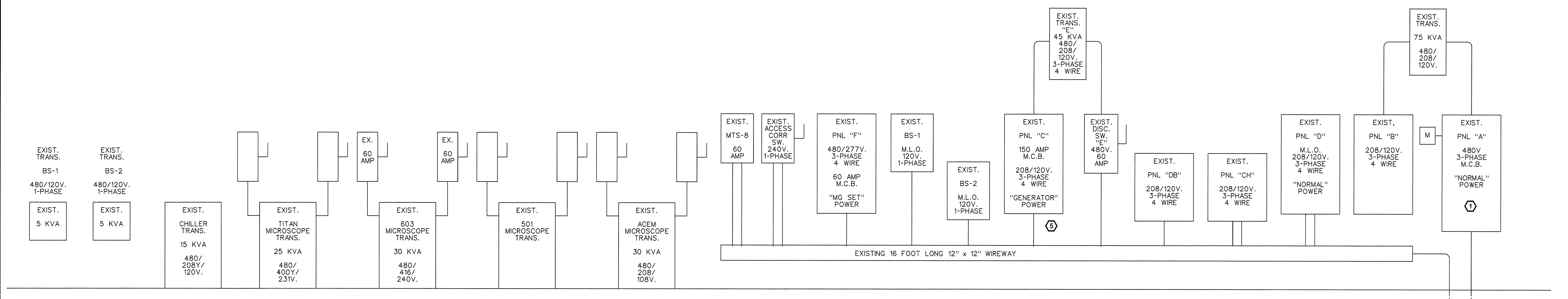
DRAWING NUMBER E3E021544D007 REV 1

GENERAL NOTES:

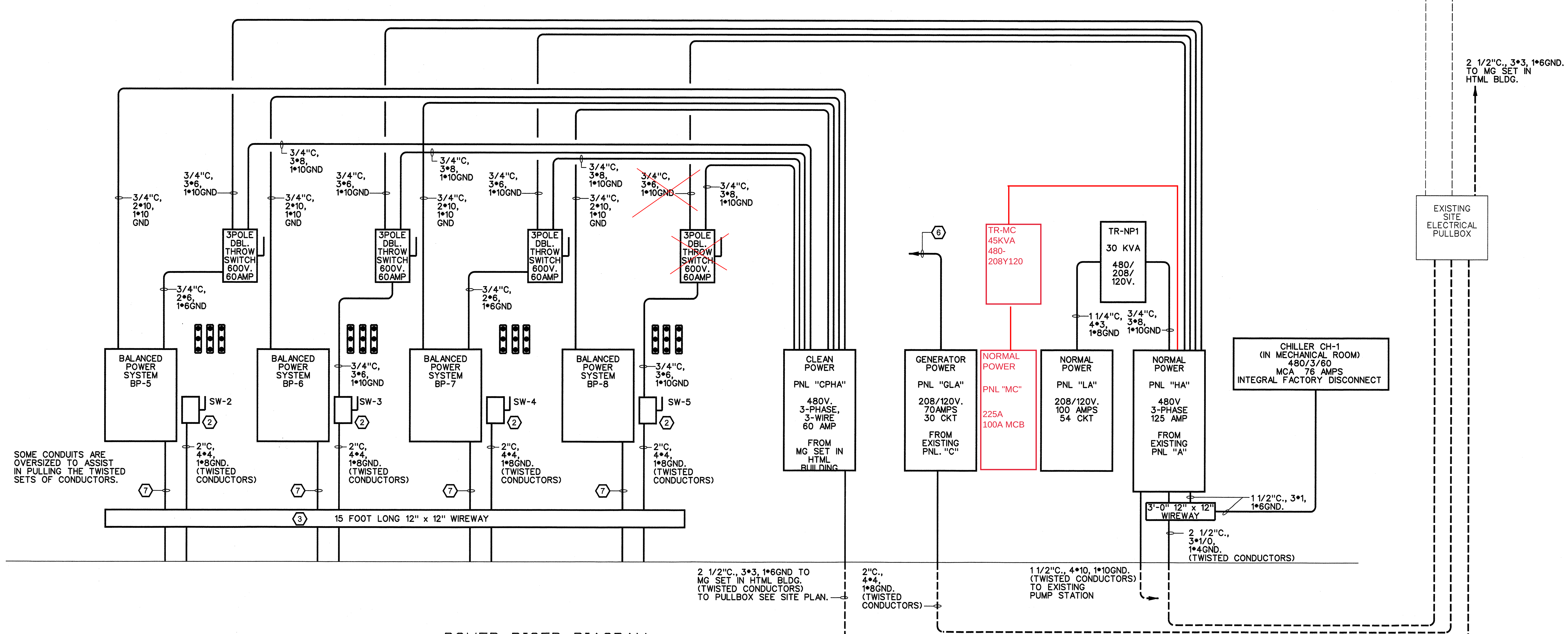
1. #10 AND #12 CONDUCTORS ROUTED INTO THE INSTRUMENT ROOMS AND CONTROL ROOMS ARE TO HAVE (6) SIX TWISTS PER FOOT.
2. #8 AND LARGER CONDUCTORS WHICH ARE TO BE TWISTED ARE TO HAVE (3) SIX TWISTS PER FOOT.

KEYED NOTES

1. EXISTING CIRCUIT BREAKER SERVING THE EXISTING PUMP STATION IS TO BE REMOVED FROM PNL "A" AND REPLACED WITH A NEW 125AMP/3POLE CIRCUIT BREAKER TO FEED PNL "HA". THE EXISTING PUMP STATION WILL BE REFED FROM PNL "HA".
2. 600 VOLT, 100 AMP, 4 POLE, FUSED DISCONNECT FOR MICROSCOPE INSTRUMENT CIRCUIT. FUSE 80 AMPS. #4 CONDUCTORS INTO THE INSTRUMENT AND CONTROL ROOMS ARE TO HAVE (3) TWISTS PER FOOT.
3. CONDUIT FOR INSTRUMENTS AND THE BALANCED POWER SUPPLY CIRCUITS FROM THE 15 FOOT WIREWAY INTO THE SERVICE TRENCHES OR INTO THE CONTROL ROOMS, INSTRUMENT ROOMS, OR CORRIDORS IS TO BE PVC CONDUIT.
4. NOT USED
5. INSTALL A NEW 70AMP/3POLE CIRCUIT BREAKER IN EXISTING PNL. "C" IN EXISTING ELECTRICAL ROOM. EXTEND 1 1/4"C., 4#4, 1#8GND. FROM PNL. "C" TO EXISTING SPARE CONDUIT TO EXISTING PULLBOX ON SOUTH SIDE OF THE BUILDING. EXTEND NEW 1 1/4"C., 4#4, 1#8GND. TO PNL. "GLA".
6. EXTEND (4) SETS OF 3/4"C., 2#12, 1#12GND. TO THE FOUR MICROSCOPE INSTRUMENT CHILLERS IN THE NEW MECHANICAL ROOM A104.
7. EXTEND (2) 1 1/2"C., (3) SETS TWISTED 2#10, 1#10GND. TO THE MICROSCOPE INSTRUMENT ROOMS AND SERVICE CORRIDOR VIA PULLBOXES EXTERIOR TO THE BUILDING. SEE DWGS. E3E021544D010, E3E021544D008 AND E3E021544D003 FOR CKTS.



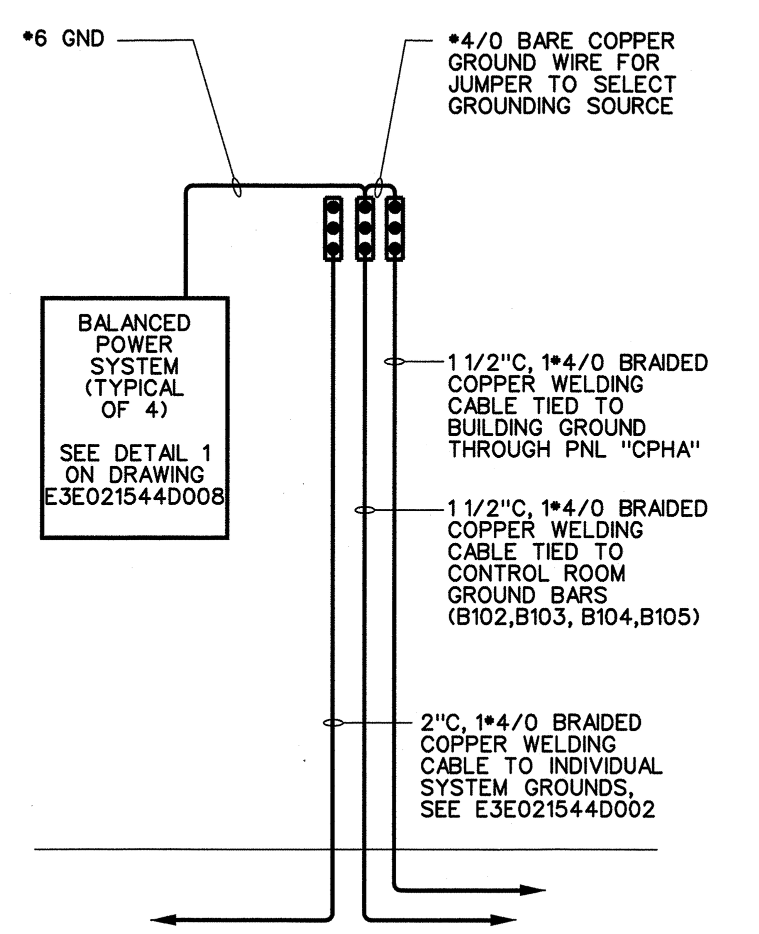
NEW ELECTRICAL ROOM



1 POWER RISER DIAGRAM
NOT TO SCALE
D009 D009

GROUNDING DETAIL GENERAL NOTES:

1. MOUNT THE TOP OF THE BALANCED POWER SYSTEM CABINET 4'-6" AFF.
2. NOT USED
3. SEE SITE PLAN - ELECTRICAL E3E021544D002 FOR ROUTING OF GROUND CONDUCTORS TO INDIVIDUAL GROUND SYSTEMS.
4. GROUND BARS IN THE ELECTRICAL ROOM AND IN THE CONTROL ROOMS ARE TO BE SOLID COPPER 1/4" THICK, 3 INCHES WIDE AND 12" LONG WITH STANDOFF BRACKET FOR MOUNTING. EACH BAR IS TO HAVE (8) PREDRILLED HOLES. MOUNT INSTRUMENT ROOM GROUND BARS 18" AFF. SUBMIT GROUND BAR CUT SHEET WITH GROUNDING SUBMITTALS.



2 GROUNDING DETAIL FOR BALANCED POWER SYSTEMS AND MICROSCOPE INSTRUMENT TRANSFORMERS
NOT TO SCALE
D009 D009

SECTION AND DETAIL KEY
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THIS DOCUMENT CONTROLLED BY CHANGE CONTROL SYSTEM
ENGINEERING PROCEDURE

REV				DESCRIPTION	DSN	DATE	CHK	DATE	PE	DATE	PM	DATE	REG	DATE	CFM	DATE	RPE	RPE NO	DATE
1	---	---	---	RECORD DRAWING			CT	9/21/11											
0	---	---	---	ISSUED - CERTIFIED FOR CONSTRUCTION	EFM	8/28/09	LMS	8/28/09	JHC	9/09	JAM	9/09	WHS	9/09	TFO	9/09	MJC	108666	8/28/09

REVISION OR ISSUE PURPOSE — REVISION APPROVALS — INTER-DISCIPLINE CHECK: ST CV EC EE EM IE M PD SE AR FPE

DSGN	M.J. CARTER	08/28/09
DRW	R.W. BOOKER	08/28/09
CHKR	E.F. MEGGS	08/28/09
PE	J H CORLEY	09/02/09
PM	J A MAYO	09/01/09
REG	W H SIDES	09/01/09
CFM	T F ORLIN	09/01/09

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PROJECT NAME:
ADV MICROSCOPY LAB EXPANSION
POWER RISER DIAGRAM

SITE	BLDG	FL	SH.	OF	
ORNL	3625	1	1	1	UNCLASSIFIED

DRAWING NUMBER E3E021544D009 REV 1

DRY TYPE TRANSFORMER SCHEDULE

LABEL	KVA	PRIMARY VOLTAGE	SECONDARY VOLTAGE	PHASE	NUMBER OF WIRES	TAPS	MOUNTING
NP1	30	480	208Y/120	3	4	(6) 2 1/2% 2+4-	TRAPEZE

PANELBOARD "HA" SCHEDULE

VOLTAGE: 480/277 VOLT, 3-PHASE, 4-WIRE
MAINS: 200A /3P MAIN CIRCUIT BREAKER
MOUNTING: SURFACE

COPPER BUS, NEUTRAL BAR AND GROUND BAR
TVSS UNIT IS TO BE MOUNTED ON TOP OF PANELBOARD

SERVES	CKT BKR	CKT NO.	PHASE - LOADING (KVA) A		B		C		CKT NO.	CKT BKR	SERVES
TVSS UNIT	30	1		1.0					2	30	GRINDER PUMP STATION
		3				1.0			4		
	3	5						1.0	6	3	
MICROSCOPE #5 TRANSFER SWITCH	60	7	6.6	6.6					8	60	MICROSCOPE #7 TRANSFER SWITCH
		9			6.6	6.6			10		
	3	11					6.6	6.6	12	3	
MICROSCOPE #6 TRANSFER SWITCH	60	13	6.6	6.6					14	60	MICROSCOPE #8 TRANSFER SWITCH
		15			6.6	6.6			16		
	3	17					6.6	6.6	18	3	
AC-4	25	19	3.3	11.7					20	50	PNLBD "LA" VIA XFMR
		21			3.3	13.2			22		
	3	23					3.3	12.7	24	3	
	20/1	25		18					26	90	CHILLER
	20/1	27				18			28		
	20/1	29						18	30	3	
	20/1	31							32	20/1	
	20/1	33							34	20/1	
	20/1	35							36	20/1	
	20/1	37							38	20/1	
	20/1	39							40	20/1	
	20/1	41							42	20/1	
MINIMUM INTERRUPTING RATING: 14,000			60.4 TOTAL "A"		61.9 TOTAL "B"		61.4 TOTAL "C"		PANELBOARD TOTAL KVA: 183.7		NOTE: MICROSCOPE CIRCUITS FOR MAINTENANCE "BURN OUT" ONLY

PANELBOARD "CPHA" SCHEDULE

VOLTAGE: 480/277 VOLT, 3-PHASE, 4-WIRE
MAINS: 60A/3P MAIN CIRCUIT BREAKER, MAIN BUSS TO BE RATED 125 AMPS
MOUNTING: SURFACE

COPPER BUS, NEUTRAL BAR AND GROUND BAR
TVSS UNIT IS TO BE MOUNTED ON TOP OF PANELBOARD

SERVES	CKT BKR	CKT NO.	PHASE - LOADING (KVA) A		B		C		CKT NO.	CKT BKR	SERVES
TVSS UNIT	30	1		6.6					2	50	MICROSCOPE #5 TRANSFER SWITCH (SERVES BP-5)
		3				6.6			4		
	3	5						6.6	6	3	
MICROSCOPE #6 TRANSFER SWITCH	50	7	6.6	3.0					8	30	SPARE CIRCUIT IN BP-5
		9			6.6	3.0			10	2	
	3	11					6.6	3.0	12	30	BP-6
MICROSCOPE #7 TRANSFER SWITCH (SERVES BP-7)	50	13	6.6	3.0					14	2	
		15			6.6	3.0			16	30	SPARE CIRCUIT IN BP-7
	3	17					6.6	3.0	18	2	
MICROSCOPE #8 TRANSFER SWITCH	50	19	6.6	3.0					20	30	BP-8
		21			6.6	3.0			22	2	
	3	23					6.6		24	20/1	SPACE
SPACE	20/1	25							26	20/1	SPACE
SPACE	20/1	27							28	20/1	SPACE
SPACE	20/1	29							30	20/1	SPACE
SPACE	20/1	31							32	20/1	SPACE
MINIMUM INTERRUPTING RATING: 14,000			35.4 TOTAL "A"		35.4 TOTAL "B"		32.4 TOTAL "C"		PANELBOARD TOTAL KVA: 103.2		NOTE: MCB SIZE IS BASED ON CURRENT MICROSCOPE AND BALANCED POWER USE METERED IN HTML MG SET

PANELBOARD "LA" SCHEDULE

VOLTAGE: 208/120V, 3PH, 4W
MAINS: 100 A/3P MAIN CIRCUIT BREAKER
MOUNTING: SURFACE

COPPER BUS, NEUTRAL BAR AND GROUND BAR

SERVES	CKT BKR	CKT NO.	PHASE - LOADING (KVA) A		B		C		CKT NO.	CKT BKR	SERVES
B105,B104,D104,D105 LTS	20/1	1	0.8	0.8					2	20/1	B102,B103,D102,D103 LTS
CORRIDORS B,B,D100 LTS	20/1	3			1.5	1.0			4	20/1	A106 LTS
A104B,A104,A102,A100 LTS	20/1	5					1.5	0.3	6	20/1	EXTERIOR BLDG LTS
A104 ELEC. TRAP PRIMER	20/1	7	0.1	0.5					8	20/1	CONTACTOR C1
SPARE	20/1	9			0.1	1.0			10	20/1	MISC REC B-100,B-102
VACUUM	20/1	11					1.7	1.0	12	20/1	MISC REC D-100,D-102
FCU-3,FCU-4,FCU-5	20/1	13	0.3	1.0					14	20/1	MISC REC B-100,B-103
REC A-101	20/1	15			1.0	1.0			16	20/1	MISC REC D-100,D-103
	20/1	17					1.0	1.0	18	20/1	MISC REC B-100,B-104
REC A-103,A-100	20/1	19	1.0	1.0					20	20/1	MISC REC D-100,D-104
COUNTER REC A-103	20/1	21			1.0	1.0			22	20/1	MISC REC B-100,B-105
COUNTER REC A-103,A-105	20/1	23					1.0	1.0	24	20/1	MISC REC D-100,D-105
REC EXTR A-100,A-104,A-106	20/1	25	1.0	1.0					26	20/1	QUAD REC A-102
A/V SYSTEM	20/1	27			1.0	1.0			28	20/1	QUAD REC A-102
SPARE	20/1	29						1.0	30	20/1	QUAD REC A-102
A101,A103,A105 LTS & EF-4	20/1	31	0.8	1.0					32	20/1	QUAD REC A-102
CARD READER & M8 CONT.	20/1	33			1.0	1.0			34	20/1	REC A-104B,A-104,EXT,A-106
SPARE	20/1	35					1.0	1.0	36	20/1	REC A-106
CARD READER & PWR SUP.	20/1	37	1.0	1.4					38	20/1	WTR HTR RM A106
CHILLER REF. MONITOR	20/1	39			0.2	1.4			40	20/1	WTR HTR RM A105
EF-5	20/1	41					1.0	0.2	42	20/1	ELEC VALVE RM A105
CHILL WTR BOOSTER PUMP	20/1	43							44	20/1	JCI-1
SPARE	20/1	45							46	20/1	JCI-2
HOT WTR BOOSTER PUMP	20/1	47							48	20/1	VAV'S
SPARE	20/1	49							50	20/1	REC A-106
REC A-106	20/1	51							52	20/1	REC A-106
REC A-106	20/1	53							54	20/1	SPARE
MINIMUM INTERRUPTING RATING: 10,000			16.1 TOTAL "A"		15.6 TOTAL "B"		13.9 TOTAL "C"		PANELBOARD TOTAL KVA: 45.6		

PANELBOARD "GLA" SCHEDULE

VOLTAGE: 208/120 VOLT, 3-PHASE, 4-WIRE
MAINS: 70A/3P MAIN CIRCUIT BREAKER
MOUNTING: SURFACE

COPPER BUS, NEUTRAL BAR AND GROUND BAR

SERVES	CKT BKR	CKT NO.	PHASE - LOADING (KVA) A		B		C		CKT NO.	CKT BKR	SERVES
INST. CHILLER #5 (RM D102)	20	1	1.0	1.0					2	20	INST. CHILLER #7 (RM D102)
	2	3			1.0	1.0			4	2	
INST. CHILLER #6 (RM D102)	20	5					1.0	1.0	6	20	INST. CHILLER (RM D102)
	2	7	1.0	1.0					8	2	
	20/1	9							10	20/1	
	20/1	11							12	20/1	
	20/1	13							14	20/1	
	20/1	15							16	20/1	
	20/1	17							18	20/1	
	20/1	19							20	20/1	
	20/1	21							22	20/1	
	20/1	23							24	20/1	
	20/1	25							26	20/1	
	20/1	27							28	20/1	
	20/1	29							30	20/1	
MINIMUM INTERRUPTING RATING: 10,000			4.0 TOTAL "A"		2.0 TOTAL "B"		2.0 TOTAL "C"		PANELBOARD TOTAL KVA: 8.0		

NOTE: INSTRUMENT CHILLER CIRCUIT BREAKERS FOR INSTRUMENT CHILLERS #5, #6, #7 AND #8 ARE TO BE SHUNT TRIP CIRCUIT BREAKERS. 24VAC SIGNAL FROM EXISTING DDC CONTROLLER ACTIVATES SHUNT TRIP CIRCUIT BREAKERS. TRENCH WATER DETECTION SYSTEM (VIA DDC CONTROLLER) ACTIVATES SHUNT TRIP CIRCUIT BREAKERS. TRANSFER FROM NORMAL POWER TO GENERATOR POWER WILL NOT ACTIVATE SHUNT TRIP CIRCUIT BREAKERS.

FIXTURE SCHEDULE

TYPE	MANUFACTURER	CATALOG NUMBER	LAMPS QTY	LAMPS WATTS	LAMPS TYPE	MOUNTING	REMARKS
A	METALUX	2GC232A125120V EB81	2	32	FLUOR T8	CEILING RECESSED	2x4 ACRYLIC LENS W/TROFFER
B	METALUX	2GC332A125120V EB81	3	32	FLUOR T8	CEILING RECESSED	2x4 ACRYLIC LENS W/TROFFER
C	METALUX NOT USED	BC225120VEB81	2	25	FLUOR T8	WALL ABOVE MIRROR	24" WALL BRACKET
D	G.E.	WP26CFL1C	1	26	FLUOR	WALL 8'-0" AFF	DIECAST ALUMINUM
E	METALUX	SS232120EB81 WIRE GUARD	2	32	FLUOR T8		48" BARE LAMP STRIP W/WIRE GUARD
⊗	SURE LITES	LPX70 BATTERY RW			LED	SEE LEGEND	EXIT SIGN W/BATTERY
F	McGRAW EDISON	HPN50120VLLB2	1	50	HPS	WALL TOP 8'-0" AFF	MONITOR 2
G	SURE LITES	HR87 MH 3BRWH 2 METAL HEADS STEEL HOUSING	2	9	INCAN	WALL TOP 9'-0" AFF	TWIN HEAD EMERGENCY W/ BATTERY
H	PORTFOLIO	C8126D268350L1WF HB26	1	26	FLUOR	CEILING RECESSED	8" DIA CLEAR LOW IRIDESCENT DIMMABLE DWNLT

PANELBOARD "BP-5" SCHEDULE

VOLTAGE: 480 VOLT, SINGLE PHASE INPUT, 120/60 VOLT OUTPUT
MAINS: MAIN LUGS FROM INTERNAL TRANSFORMER
MOUNTING: SURFACE

PART OF BALANCED POWER SYSTEM BP-5

SERVES	CKT BKR	CKT NO.	PHASE - LOADING (KVA) A		B		CKT NO.	CKT BKR	SERVES
RM. B105 REC.WEST WALL	20	1	0.5	0.5			2	20	RM. D105 REC. WEST WALL
	2				0.5	0.5		2	
RM. B105 REC.NORTH WALL	20	3	0.5	0.5			4	20	RM. D105 REC. EAST WALL
	2				0.5	0.5		2	
RM. B105 REC.EAST WALL	20	5	0.5	0.5			6	20	RM. D100 REC. WEST WALL
	2				0.5	0.5		2	
SPARE	20	7					8	20	SPARE
	2							2	
SPARE	20	9					10	20	SPARE
	2							2	
MINIMUM INTERRUPTING RATING: 14,000			3.0 TOTAL "A"		3.0 TOTAL "B"		PANELBOARD TOTAL KVA: 6.0		

PANELBOARD "BP-6" SCHEDULE

VOLTAGE: 480 VOLT, SINGLE PHASE INPUT, 120/60 VOLT OUTPUT
MAINS: MAIN LUGS FROM INTERNAL TRANSFORMER
MOUNTING: SURFACE

PART OF BALANCED POWER SYSTEM BP-6

SERVES	CKT BKR	CKT NO.	PHASE - LOADING (KVA) A		B		CKT NO.	CKT BKR	SERVES
RM. B104 REC.WEST WALL	20	1	0.5	0.5			2	20	RM. D104 REC. WEST WALL
	2				0.5	0.5		2	
RM. B104 REC.SOUTH WALL	20	3	0.5	0.5			4	20	RM. D104 REC. EAST WALL
	2				0.5	0.5		2	
RM. B104 REC.EAST WALL	20	5	0.5	0.5			6	20	RM. D100 REC. WEST WALL
	2				0.5	0.5		2	
SPARE	20	7					8	20	SPARE
	2							2	
SPARE	20	9					10	20	SPARE
	2							2	
MINIMUM INTERRUPTING RATING: 14,000			3.0 TOTAL "A"		3.0 TOTAL "B"		PANELBOARD TOTAL KVA: 6.0		

PANELBOARD "BP-7" SCHEDULE

VOLTAGE: 480 VOLT, SINGLE PHASE INPUT, 120/60 VOLT OUTPUT
MAINS: MAIN LUGS FROM INTERNAL TRANSFORMER
MOUNTING: SURFACE

PART OF BALANCED POWER SYSTEM BP-7

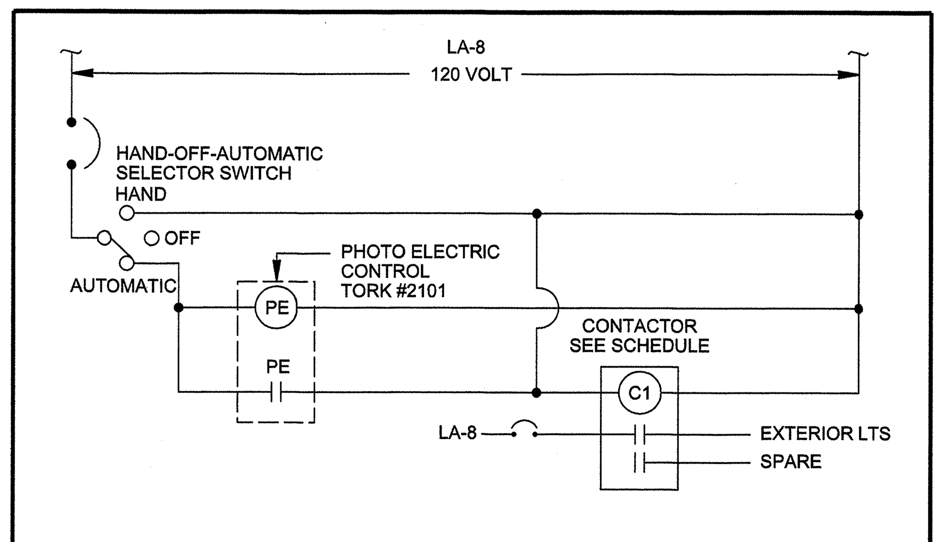
SERVES	CKT BKR	CKT NO.	PHASE - LOADING (KVA) A		B		CKT NO.	CKT BKR	SERVES
RM. B103 REC.WEST WALL	20	1	0.5	0.5			2	20	RM. D103 REC. WEST WALL
	2				0.5	0.5		2	
RM. B103 REC.NORTH WALL	20	3	0.5	0.5			4	20	RM. D103 REC. EAST WALL
	2				0.5	0.5		2	
RM. B103 REC.EAST WALL	20	5	0.5	0.5			6	20	RM. D100 REC. WEST WALL
	2				0.5	0.5		2	
SPARE	20	7					8	20	SPARE
	2							2	
SPARE	20	9					10	20	SPARE
	2							2	
MINIMUM INTERRUPTING RATING: 14,000			3.0 TOTAL "A"		3.0 TOTAL "B"		PANELBOARD TOTAL KVA: 6.0		

PANELBOARD "BP-8" SCHEDULE

VOLTAGE: 480 VOLT, SINGLE PHASE INPUT, 120/60 VOLT OUTPUT
MAINS: MAIN LUGS FROM INTERNAL TRANSFORMER
MOUNTING: SURFACE

PART OF BALANCED POWER SYSTEM BP-8

SERVES	CKT BKR	CKT NO.	PHASE - LOADING (KVA) A		B		CKT NO.	CKT BKR	SERVES
RM. B102 REC.WEST WALL	20	1	0.5	0.5			2	20	RM. D102 REC. WEST WALL
	2				0.5	0.5		2	
RM. B102 REC.SOUTH WALL	20	3	0.5	0.5			4	20	RM. D102 REC. EAST WALL
	2				0.5	0.5		2	
RM. B102 REC.EAST WALL	20	5	0.5	0.5			6	20	RM. D100 REC. WEST WALL
	2				0.5	0.5		2	
SPARE	20	7					8	20	SPARE
	2							2	
SPARE	20	9					10	20	SPARE
	2							2	
MINIMUM INTERRUPTING RATING: 14,000			3.0 TOTAL "A"		3.0 TOTAL "B"		PANELBOARD TOTAL KVA: 6.0		



OUTSIDE LIGHTING CONTROLS

CONTACTOR SCHEDULE

ITEM NO.	MANUFACTURER	CATALOG NUMBER	LINE VOLTS	CONTROL VOLTS	ACCESS.	REMARKS
C1	ASCO	91822031	120V	120V	47D	NEMA 1 ENCLOSURE

NUMBER OF SECTION OR DETAIL
DRAWING ON WHICH SECTION OR DETAIL IS TAKEN
DRAWING ON WHICH SECTION OR DETAIL IS SHOWN
SECTION AND DETAIL KEY

THIS DOCUMENT CONTROLLED BY
CHANGE CONTROL SYSTEM
ENGINEERING PROCEDURE

REV	CHANGE TYPE	CHANGE CONTROL SYSTEM	CHANGE REQUEST NUMBER	DESCRIPTION	DSN	DATE	CHK	DATE	PE	DATE	PM	DATE	REQ	DATE	CFM	DATE	RPE	RPE NO	DATE
1	---	---	---	RECORD DRAWING			CT	4/26/11											
0	---	---	---	ISSUED - CERTIFIED FOR CONSTRUCTION	EFM	8/28/09	LMS	8/28/09	JHC	9/09	JAM	9/09	WHS	9/09	TFO	9/09	MJC	105666	8/28/09

REVISION OR ISSUE PURPOSE | REVISION APPROVALS | INTER-DISCIPLINE CHECK: MEN/ARC | ST | CV | EC | EE | EM | IE | M | PD | SE | AR | FPE | CER/RCP | EWL

BWSC BARGE WAGGONER SUMNER & CANNON, INC.
10133 Sherrill Blvd., Suite 200, Knoxville, Tennessee 37932 PHONE (865) 637-2810 FAX (865) 673-8554

RPE	
DSGN M.J. CARTER	08/28/09
DRW R.W. BOOKER	08/28/09
CHKR F.E. MEGGS	08/28/09
PE J H CORLEY	09/02/09
PM J A MAYO	09/01/09
REQ W H SIDES	09/01/09
CFM T F ORLIN	09/01/09
REV. / DATE / REVISION Ø APPROVALS	DATE

UT-BATTELLE
Oak Ridge National Laboratory
managed for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC05-00OR22725
UT-BATTELLE, LLC, • Oak Ridge, Tennessee

PROJECT NAME:
ADV MICROSCOPY LAB EXPANSION
ELECTRICAL SCHEDULES

SITE	BLDG	FL	SH.	OF	
ORNL	3625	1	1	1	UNCLASSIFIED

DRAWING NUMBER E3E021544D010 REV 1

E3E021544D010

Pro2Serve®

Professional Project Services, Inc.
545 Oak Ridge Turnpike
Oak Ridge, TN 37830
(865) 220-4300
www.p2s.com

September 25, 2009

Mr. John Mayo, Jr.
UT-Battelle, LLC
Oak Ridge National Laboratory
Building 4500N
P.O. Box 2008, Mail Stop 6336
Oak Ridge, TN 37831-6336

Subject: **Summary Report of Geotechnical Support**
Site Preparation for Advanced Microscopy
Laboratory Expansion (AMLE)
Oak Ridge National Laboratory
Oak Ridge, Tennessee
Pro2Serve Project No. 8701-712-40

Dear Mr. Mayo:

As authorized by you, the following summary report describes the geotechnical engineering support services provided by Professional Project Services, Inc. (Pro2Serve) during site preparation activities for the Advanced Microscopy Laboratory Expansion (AMLE) project. The report initially describes the site location and project description, followed by the scope of services provided by Pro2Serve, culminating with findings. Attachments A and B to this report contain daily e-mail reports of site visits and selected photographs made by the writer during site visits.

Site Location and Project Description

The Advanced Microscopy Laboratory (AML), Building 3625, formerly known as the Advanced Materials Characterization Laboratory, is situated along the south side of White Oak Creek, immediately east of Incinerator Drive within the south-central portion of the ORNL main campus in Bethel Valley near Oak Ridge, Tennessee. The site is bordered by Haw Ridge to the south, paved parking areas and Incinerator Drive to the west, White Oak Creek to the north, and Building 4515 to the east.

ORNL plans to expand the existing AML building along the southwestern side to house a number of sensitive materials characterization instruments, including next generation scanning transmission electron microscopes (STEMs). In order to prepare the site for the building expansion, the existing geogrid-reinforced building pad is being extended to the southwest. Site preparation includes undercutting a portion of the new building area up to about 8 feet deep, placement of geotextile, select crushed stone consisting of no. 57 stone and mineral aggregate base, and up to three layers of biaxial geogrid.

Barge Waggoner Sumner and Cannon, Inc. (BWSC) prepared the design for site preparation. The design is depicted on UT-Battelle Drawings C3E021544B016 through B019 and the project technical specifications. Blaine Construction was the general contractor and AVISCO was the earthmoving subcontractor for the site preparation work.

Scope of Services Performed by Pro2Serve

The writer performed the following scope of services:

1. Reviewed technical submittals for the geogrid, geotextile for engineered fill, geotextile for rip rap, no. 57 stone, mineral aggregate base, and site dewatering plan. Review comments were forwarded to Mr. John Ellis, P.E., Civil/Structural Engineer with UT-Battelle, LLC, via e-mail. All technical submittals were found to be in accordance with the technical specifications. The following geosynthetics products were used on the project:
    a. Geogrid – FORNIT® 30 by HUESKER®
    b. Geotextile for engineered fill - GEOTEX® 651 by Propex Geosynthetics
    c. Geotextile for rip rap - GEOTEX® 1071 by Propex Geosynthetics

2. Observed site preparation field activities a on a part-time, spot check basis. Site visits were performed on the following dates:
    a. Wednesday, August 12, 2009
    b. Friday, August 14, 2009
    c. Thursday, August 20, 2009
    d. Monday, August 24, 2009
    e. Tuesday, August 25, 2009
    f. Wednesday, August 26, 2009
    g. Friday, August 28, 2009

    E-mail reports of site visits are included in Attachment A to this report. Note no e-mail reports were written and submitted for site visits made on August 14, and 20, and 28, 2009, since no work was being performed at the times these site visits were performed. Selected photographs made by the writer during the site visits are provided in Attachment B.

    Quality control testing of the engineered fill was performed by the Contractor's soil testing firm. The results of the quality control testing will be reported by others.

Findings

Site preparation work observed by the writer was performed in general accordance with the drawings and technical specifications. Subsurface conditions observed by the writer were consistent with subsurface conditions described in Pro2Serve's report of Foundation and Site Preparation Recommendations for the project dated April 21, 2009.

Closing

Pro2Serve is pleased to provide this report for UT-Battelle, LLC. If you have any questions, please contact us.

Sincerely,

PROFESSIONAL PROJECT SERVICES, INC.

John D. Long

John D. Long, P.E.
Sr. Geotechnical Engineer

Attachments: as stated

JOHN D. LONG
REGISTERED ENGINEER
AGRICULTURE
COMMERCE
No.020423
STATE OF TENNESSEE

John D. Long 09/25/2009

Attachment A
E-mail Reports of Site Visits

From: Long, John D[redacted]
Sent: Thursday, August 13, 2009 8:59 AM
To: Mayo Jr, John A.; Palau, Gerald L.; Ellis, John A.
Subject: AMLE Site Visit - Wednesday August 12, 2009

Gentlemen,

I visited the AMLE site yesterday morning from approximately 11:00 a.m. to 11:30 a.m. to observe progress of the undercut excavation for the new building. Upon arrival to the site I met with Dudley Lightle, superintendent with Blaine Construction. Dudley went over the AHA checklist with me and we discussed the work progress to date and Blaine's planned future work.

When I arrived to the site I observed a strip about 10 ft wide had been excavated down to the top of the first (upper) geogrid layer along the eastern side of the undercut. Laborers were shoveling crushed stone off of the existing geogrid and laying the geogrid back against the eastern excavated slope. The existing geogrid appeared to be the TENSAR BX6200 product. The Contractor was doing a good job protecting the existing geogrid. Throughout most of the length of the undercut there was more than 3 ft of geogrid available for overlap. Dudley and I discussed extending the new geogrid slightly over the excavated slope in some areas to provide adequate overlap where the exposed existing geogrid was shorter. The excavation was dry at this depth. No groundwater seepage was observed. I observed several layers of bedded limestone along the south slope of the undercut near the southeastern corner of the excavation, as expected.

I observed 2 rolls of geogrid (Fornit 30) and 1 roll of geotextile (Geotex 651) had been delivered to the site. I confirmed that these materials are the same as previously approved by Engineering for construction.

I made several photographs of the work in progress. I will forward these photographs later, after downloading from my camera.

Regards,

John D. Long, P.E.
Sr. Geotechnical Engineer
Pro2Serve
[redacted]

From: Long, John D.
Sent: Monday, August 24, 2009 2:34 PM
To: 'Palau, Gerald L.'
Cc: 'Ellis, John A.'; [redacted]
Subject: AMLE Site Visit Today

Hello Gerry,

I am dropping you a quick note to let you know I got your telephone message and I visited the AMLE site today and met with Dudley Lightle. We <u>will not</u> need to excavate further into the bank to tie into the geogrid. I plan to call Dudley in the morning and return to observe the subgrade in the deep undercut area once it is fully exposed. They finally dug deep enough to reach the bottom of the no. 57 stone layer. The no. 57 stone layer is making water as expected. It should dry up eventually. Things are pretty much as expected. Blaine/AVISCO has been doing a good job protecting the existing geogrid and geotextile.

I will prepare a more detailed report for later submission to everyone.

Regards,

John d. Long, P.E.
Sr. Geotechnical Engineer
Pro2Serve
[redacted]

From: Long, John D.
Sent: Tuesday, August 25, 2009 11:18 AM
To: 'Palau, Gerald L.'
Cc: 'Ellis, John A.';[redacted]
Subject: AMLE Site Visit Monday Afternoon August 24, 2009 and Tuesday Morning August 25, 2009

Gerry,

I visited the AMLE site yesterday afternoon from approximately noon until 12:30 p.m. and again this morning from approximately 8:30-9:00 a.m. to observe the undercut for the building expansion. Upon arrival to the site I met with , Dudley Lightle, Superintendent with Blaine Construction and discussed construction progress.

Yesterday afternoon, I observed Blain had uncovered most of the existing geogrid and geotextile in the deeper undercut area. Perched groundwater was encountered in the No. 57 stone layer, as expected. Blaine had established a temporary sump in the northern portion of the undercut and was pumping water out of the excavation. There was a good steady stream of water flowing out of the No. 57 stone layer. The subgrade was not yet exposed in the base of the undercut. Dudley indicated he planned to complete the undercut in the afternoon. He asked me to give him a call tomorrow morning to check on progress. He expected the excavation would be completed Tuesday morning and I would be needed to return to observe the subgrade. I observed two or three places each about 10 feet long in the bottom layer of geogrid where the existing geogrid protruded only about 12 to 18 inches out from the cut slope. I informed Dudley that we could lap the geogrid up on the slope some to compensate for the shorter lengths of exposed geogrid. There was no need to cut the slope back further to expose more geogrid.

I returned to the site this morning, after receiving a phone call from Dudley Lightle requesting that I observe the subgrade in the deeper undercut area. While I was on site, Blaine completed the deeper undercut. The subgrade was bladed smooth as specified. I probed the base of the excavation with a steel probe rod. The subgrade appeared to be firm to stiff consistency clay and silty clay. Limestone bedrock was exposed in the extreme southern portion of the undercut and along the south excavation slope. The base of the excavation was wet. Most of the perched water from the No. 57 stone had drained down. The No. 57 stone was still making a little water. I told Dudley that the subgrade was suitable for placement of geotextile and geogrid and backfilling. We discussed the backfilling process and the need for density testing of the pug mix layers, after each layer is placed and compacted. Dudley asked if the sump with CMP is needed, since the No. 57 stone has essentially dried up and there is no groundwater seeping in from outside the excavation. It will be difficult to remove after backfilling. I told him that I see no need for placement of the vertical CMP sump, based on observed conditions. I recommended that Blaine simply maintain a low area in the northern end of the excavation and slope the backfill slightly to drain to the low area for removal of surface water. I anticipate that once the No. 57 stone layer is placed in the base of the undercut, the backfill will be above the perched water table and dewatering of perched water will no longer be required.

I will be making spot checks of the construction over the next few days to observe placement of geotextile, geogrid, and engineered fill (i.e., pug mix) in the deep undercut.

Regards,

John D. Long, P.E.
Sr. Geotechnical Engineer
Pro2Serve
[redacted]

From: Long, John D.
Sent: Wednesday, August 26, 2009 10:30 AM
To: 'Palau, Gerald L.'
Cc: 'Ellis, John A.';[redacted]
Subject: AMLE Site Visit Tuesday Afternoon August 25, 2009 and Wednesday Morning August 26, 2009

Gerry,

I visited the AMLE site yesterday afternoon from approximately noon until 12:30 p.m. and again this morning from approximately 8:40-9:15 a.m. to observe backfilling of the undercut for the building expansion. Upon arrival to the site I met with Dudley Lightle, Superintendent with Blaine Construction and discussed construction progress.

Yesterday afternoon, I observed Blain had placed the geotextile and first layer of geogrid in the base of the excavation in the deeper undercut area and was placing the 1-foot-thick layer of No. 57 stone over the first layer of geogrid. No. 57 stone had been placed over roughly the southern 60% of the undercut. I observed the exposed geotextile and geogrid. This layer of No. 57 stone had not yet been finished graded and the geotextile had not yet been lapped over along the perimeter. Overlaps and placement of these materials, visible in the base of the undercut, were in accordance with the specifications. A very small flow of groundwater was draining into the sump in the northern end of the excavation, from the original No. 57 stone layer. The sump pump was shut off at this time. Groundwater flow was not sufficient to keep the pump running continuously. AVISCO had not yet placed geotextile and geogrid in the sump area. A ramp had been excavated along the western side of the undercut to allow dump trucks to deliver crushed stone to the undercut area. (I forgot to mention that this ramp was visible during my site visit earlier yesterday morning.)

I returned to the site this morning to observe placement of pug mix and geogrid layers in the area of deeper undercut. AVISCO had placed the third layer of geogrid (i.e. third layer of geogrid from the bottom) in the base of the excavation and was spreading a layer of pug mix over the geogrid. Overlaps and placement of the geogrid was in accordance with the specifications. Pug mix was being spread with a small dozer. The excavation was dry. No groundwater seepage was observed in the excavation. I observed a large vibratory compactor at the site. Dudley said that AVISCO was using this compactor to compact the pug mix. A Shield Engineering Technician was on site. He had performed field density tests on the underlying layer of compacted pug mix prior to my arrival. Dudley indicated that the tests exceeded specified requirements. Also Dudley indicated that the vibrations from the large compactor had caused concern from the folks in the AML building yesterday. AVISCO was now performing a minimum amount of compaction with the vibrator turned on to reduce impacts on the AML equipment. We agreed that some vibration is needed to get compaction, and there is not a need to keep the vibrator running continuously. Dudley asked about possibly stopping the finished grade about 8 inches below design elevation, since spoils will be generated during foundation excavation that could be used to reach finished grade. This would avoid the need for spoiling materials when foundation excavation is started. I told Dudley that this sounded like a good idea to me if Blaine would be proceeding with the next phase of work, but he would need to discuss this with Gerry Palau and get approval from UTB.

Regards,

John D. Long, P.E.
Sr. Geotechnical Engineer
Pro2Serve
[redacted]

From: Long, John D.
Sent: Thursday, August 27, 2009 8:41 AM
To: 'Palau, Gerald L.'
Cc: 'Ellis, John A.';[redacted]
Subject: AMLE Site Visit Wednesday Afternoon August 26, 2009

Gerry,

I visited the AMLE site yesterday afternoon from approximately 4:15 p.m. until 5:15 p.m. to observe subgrade preparation and backfilling of the undercut for the building expansion. Upon arrival to the site I met with , Dudley Lightle, Superintendent with Blaine Construction, and discussed construction progress.

While on site, I observed that AVISCO was nearing completion of backfilling of the deeper undercut area with pug mix (i.e., engineered fill). Pug mix was being spread with the small dozer and trackhoe and compacted with the larger vibratory compactor. The vibrator was turned off most of the time during compaction. The backfilled excavation was approximately 1 to 2 feet below finish subgrade grade elevations. The pug mix was becoming dry. Dudley said that they wet (moistened) some of the stone placed earlier in the day, because it was drying out before they could get it placed. I observed the subgrade in the area of the shallow undercut along the western side of the site, where a single layer of geogrid was to be placed. The subgrade was stable under truck traffic which was delivering pug mix to the site. I probed the subgrade in the northwestern portion with a steel probe rod. The subgrade was firm to very stiff and very rocky. AVISCO placed the geogrid over the shallow undercut area. At my request, the geogrid was extended at least 3 feet east of the western edge of the upper layer of the underlying geogrid placed in the deeper undercut area. The geogrid was placed and overlapped in accordance with the drawings and specifications. AVISCO began placing the first layer of pug mix over the geogrid with a trackhoe. Because the pug mix was drying out, Dudley said they would wet it first thing in the morning to facilitate proper compaction.

This site visit completes my spot-check observations during site preparation for this project. Dudley indicated that AVISCO would likely complete placement of the pug mix (i.e., engineered fill) before lunch tomorrow (08-27-09).

Regards,

John D. Long, P.E.
Sr. Geotechnical Engineer
Pro2Serve
[redacted]

Attachment B
Selected Photographs Made During Site Visits

Photo 1 - View of undercut in main building area during excavation looking north 08-12-200. Note upper layer of existing geogrid is exposed and folded back on slope.

Photo 2 - View of rolls of geogrid and geotextile delivered to site 08-12-2009.

Photo 3 - View of undercut in main building area during excavation looking north 08-14-2009. Multiple layers of existing geogrid have been exposed and folded back on slope.

Photo 4 - View of undercut in main building area during excavation looking north 08-20-2009. Site received rain this afternoon prior to making photo and rain water has accumulated in the excavation.

**Photo 5 - View of undercut in main building area during excavation looking south 08-24-2009.
Note existing basal layer of No. 57 Stone has been exposed and "perched" groundwater is draining from the stone.**

Photo 6 - View of sump pump operating in northern end of excavation in main building area to remove "perched" groundwater looking north 08-24-2009.

Photo 7 - View of limestone bedrock layers exposed in southern end of main building area undercut looking southeast 08-24-2009.

Photo 8 - View of geotextile and first layer of geogrid placed beneath main building area looking north 08-25-2009.

Photo 9 - View of no. 57 stone being placed in bottom of undercut in main building area looking south 08-25-2009.

Photo 10 - View of sump pump operating in northern end of main building area undercut looking east 08-25-2009.

Photo 11 - View of workers placing second layer of geogrid in southern end of main building area undercut looking east 08-25-2009.

Photo 12 - View of small dozer spreading mineral aggregate base over second layer of geogrid below main building area looking northeast 08-25-2009.

Photo 13 - View of undercut in main building area during placement of mineral aggregate base over second layer of geogrid looking west 08-25-2009. Note ramp excavated previously to provide access for backfilling.

Photo 14 - View of large smooth-drum vibratory compactor used to compact mineral aggregate base backfill looking north 08-26-2009.

Photo 15 - View of main building area undercut after placement of third (last) layer of geogrid looking north 08-26-2009.

Photo 16 - View of office/service building area after placement of geogrid on prepared subgrade looking northwest 08-26-2009.

Photo 17 - View of trackhoe placing mineral aggregate base over geogrid in office/service building area looking northeast 08-26-2009.

Photo 18 - View of site after new building pad is complete looking north 08-27-2009.

Photo 19 - View of site after new building pad is complete looking east 08-27-2009.

OAK RIDGE NATIONAL LABORATORY

MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

ENGINEERING TRANSMITTAL

XMTL. No.	ISSUE DATE
JAM-09-062	09/28/09
PROCUREMENT BY **	**FIELD WORK BY**
UT-B	Blaine Construction
PROJECT No.	**ACCOUNT No.**
	K-9068A10

PROJECT TITLE
ADVANCED MICROSCOPY LABORATORY EXPANSION

JOB TITLE
FINAL GEOTECHNICAL REPORT

BLDG	SITE	PROJECT RECORD No.
3625	ORNL	X-2008-0026

DISTRIBUTION / QUANTITIES

	FUNCTION	KR	NAME	BLDG	Mail Stop	Xmtl	Dwg. Red/Full	B/M	D/S Spec	*
PROJECT MANAGEMENT	Project Manager (PM)		J.A.MAYO	4500N	6336	1				1
	Principal Engr. (PE)		J.H.CORLEY	4505	6225	1				1
	Lab Div Rep		W.H.SIDES	3625	6048	1				1
	Constr Field Rep (CFR)		G.L.PALAU	4505	6218	1				1
	Procurement Coord		A.G.SHILLINGS	1060COM	6339	1				1
	Report/Analysis (RP)		A.D.HALE	4500N	6336					
			G.L.SCOTT	4500N	6336					
			B.L.MORGAN	4500N	6336	1				1
			K.D.CALFEE	3017	6052					
			J.L.STELLERN	4500N	6336	1				1
			K.B.JESKIE	4500N	6230					
			S.J.PENNYCOOK	3025M	6030					
			J.L.BROWN	4515	6062	1				1
			T.F.ORLIN	4500N	6175	1				1
DESIGN	Architect		R.C.PETERS	4500N	6336	1				1
	Structural		J.A.ELLIS	4500N	6336	1				1
	Electrical Engr		C.TAVINO	4500N	6336	1				1
	Instrument Engr									
	Civil Engr									
	Mechanical Engr.		W.K.THOMAS	4500N	6336	1				1
			L.C.JONES	4500N	6336					
			D.L.HAMMAKER	BWSC						
			K.CRAFT	BWSC						
			H.BUCKBERRY	BWSC						
SPECIAL	Quality (Q&A)									
	SHEST		W.S.UNDERWOOD	4505	6218	1				1
	Environ. Protection		E.L.RYAN	5500	6395	1				1
	Fire Protection		E.LAUBACH	4500N	6424	1				1
	Radiation Protection		B.A.POWERS	3603	6002	1				1
	P&E									
	Procurement									
	Laboratory Protection									
			J.H.WATSON	6011	6346					
			RICHARD EMISON	BLAINE		1				1
			WAYNE VOGEN	VIB. ENG						
			D.M.GERRICK	2518	6322	1				1
			FRED KERN	J&A ENT.						
			PETE BIGERAL	PDC						
OTHER	DOEORO		D.E.GOUND	4500N	6269	1				1
			LARRY ALLARD	4515	6062					
	Data Center		KAREN GRAY	4500N	6423	1				1
	Retain PWF									
					TOTAL	21				21

ISSUE FOR:

☒ Info/Record ☐ Procurement ☐ Approval
☐ Approved ☐ Comment ☐ CFC

Comments To: By(Date)

LIST OF ATTACHMENTS AND INFORMATION

☒ RC ☐ NoRC

Summary Report of Geotechnical Support-Site Preparation for Advanced Microscopy Laboratory Expansion (AMLE); dated September 25, 2009; author: John Long (Pro2Serve).

RECEIVING INSPECTION REQUIRED

☒ (1) Routine ☐ (2) Special

Refer Technical Questions
To:
Phone:

**** If company, list responsible group, e.g. Engineering, Maintenance, others. Explain above.**

Return originals to:

Originated By	Section (Group)	Division (Department)	Principal Engineer	Project Engineer/Manager
J.A.MAYO	PROJECT MGMT	FDD	J.H.CORLEY	J.A.MAYO

Report of Geotechnical Exploration
Additions to Advanced Materials Laboratory (AML)
Oak Ridge, TN

Prepared for:
Barge Waggoner Sumner and Cannon
Oak Ridge, Tennessee 37830

Prepared by:
Shield Engineering, Inc.
300 Forestal Drive
Knoxville, TN 37918

Shield Project No. 1095011-01

March 23, 2009

TABLE OF CONTENTS

SHIELD ENGINEERING, INC.

March 23, 2009

Mr. Keith Craft
Barge Waggoner Sumner and Cannon
1009 Commerce Park Drive
Suite 500
Oak Ridge, TN 37830

(o): 865-481-0496
(f): 865-481-3895

Subject: **Report of Geotechnical Exploration**
Additions to Advanced Materials Laboratory AML
Oak Ridge National Laboratory
Oak Ridge, Tennessee
Shield Project No. 1095011-01

Dear Mr. Craft:

Shield Engineering, Inc. (Shield) has completed our report of geotechnical exploration for Additions to the Advanced Materials Laboratory (AML) at Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee in general accordance with our proposal P2009-715 dated February 6, 2009. The purpose of our geotechnical exploration was to determine general subsurface conditions and obtain data to provide geotechnical recommendations and considerations for design and construction of the proposed building and pavements. The scope of work authorized for this project included field activities, laboratory testing, and report preparation. Presented herein are the results of Shield's subsurface exploration, conclusions and geotechnical recommendations as they relate to our understanding of the proposed project.

1.0 PROJECT INFORMATION

Project information has been derived from discussions with Mr. John Long with Pro2Serve and emails from you. Based on the information provided, a small addition is scheduled for the AML. A previous geotechnical exploration was conducted in 2001 for the main structure but some concerns exist about subsurface conditions in the area of the addition. Additional subsurface data and index properties of the soils are needed. The site location is shown in Figure 1

00 Forestal Drive
'noxville TN 37918

www.shieldengineering.com

Telephone 865 544 5959
Fax 865 544 5885

2.0 OBJECTIVE OF SUBSURFACE EXPLORATION

The objectives of this subsurface exploration will be to assess general subsurface conditions and provide geotechnical-related recommendations/considerations for site preparation and foundations for the proposed building.

3.0 FIELD EXPLORATION PROCEDURES

The field exploration was performed on February 19, 2009 by our subcontractor, Tri-State Testing and Drilling, under the direction of Shield's on-site representative The borings were drilled with a truck-mounted drill rig.

A total of 4 test borings were extended to auger refusal depths ranging from 9.3 feet to 18.7 feet. The boring locations were selected and located in the field by BWSC. The location of each boring is shown on the Boring Location Plan (Figure 2, in Appendix A).

The test borings were advanced utilizing continuous flight hollow stem augers, with standard penetration test (SPT) and soil sampling performed by means of the split-barrel sampling procedure in general accordance with ASTM D 1586. In this procedure, a 2 inch O.D., split-barrel sampler is driven into the soil a distance of 18 inches by a 140-pound hammer falling 30 inches The number of blows required to drive the sampler through the final 12 inches of penetration is termed the "standard penetration resistance" or "N-value" and is indicated for each sample on the boring logs in Appendix B. This value can be used as a qualitative indication of the consistency of cohesive soils. This indication is qualitative, because many factors can significantly affect the N-value and prevent direct correlation between samples obtained by various drill crews, drill rigs, drilling procedures, and hammer-rod-spoon assemblies.

One relatively undisturbed samples were obtained by pushing a section of 3-inch O.D., 16-gauge steel tubing into the soil at the desired sampling level. The sampling procedure is described by ASTM D 1587. The tube, together with the encased soils, was carefully removed from the ground, made airtight, and transported to our laboratory.

The recovered soil samples were visually classified in the field by our staff professional trained in geotechnical engineering. The soil samples were labeled, placed in appropriate containers, and transported to Shield's Knoxville laboratory where they were re-examined by our geotechnical engineer and visually classified. Selected soil samples were subjected to laboratory testing and analysis. The laboratory-testing program is addressed in the subsequent section "Laboratory Testing Program".

The soil samples and field data collected during the field exploration were used to assist in the description of the subsurface conditions, and for engineering evaluation purposes. The subsurface conditions observed at each test boring location are detailed on the Geotechnical Boring Logs in Appendix B, at the end of this report.

Groundwater measurements were observed during augering in each boring, at the termination of the boring, and at approximately 24 hours after the completion of the borings. The groundwater levels are shown on the Geotechnical Boring Logs and Subsurface Fence Diagrams in Appendix B.

Upon completion of drilling, the borings were plugged and abandoned in general accordance with UT Battelles's abandonment procedures by backfilling full depth with bentonite. The borehole plugging and abandonment forms are included in Appendix C.

Prior to the start of the exploration, ORNL Radiation Control Technicians (RCTs) checked the drill rig to verify that it was free of radiation above background level. Subsequently, upon completion of the subsurface exploration, ORNL RCTs verified that the soil samples, rock core, and our drilling equipment were free of significant amounts of radiological contamination prior to our demobilization from the site.

4.0 LABORATORY TESTING PROGRAM

The purpose of the laboratory testing program was to evaluate the mechanical and index properties of the subsurface soils encountered, and to assist in soil classification and relative strength evaluations. Representative soil samples were obtained at various depth intervals within the test borings for laboratory testing and analysis. These samples were divided into groups of similar samples according to color and visual classification. The laboratory testing program included the following tests:

- Natural moisture content tests (ASTM D 2216)
- Atterberg limits (ASTM D 4318)
- Grain size analysis (ASTM D 422)
- Classification in accordance with the Unified Soil Classification System (ASTM D 2487)

Summary of Laboratory Testing:

The laboratory testing generally indicated that the soils are typical of soils encountered in the Valley and Ridge Physiographic Providence. The results reported are only for the samples that were selected for testing.

Atterberg Limit, grain size analysis, and natural moisture content testing were performed to assist in the classification and characterization of the soils encountered on site. Testing revealed the soils have Liquid Limits ranging from 20 to 54 and Plasticity Indices ranging from 3 to 29. Based on the grain size analysis and Atterberg Limit test results; the soils that were tested classify as lean clay (CL), silts (ML), and fat clay (CH) based on the Unified Soil Classification System (USCS) per the results attached. Natural moisture content testing was performed on random samples and revealed natural moisture contents ranging from 3.7 % to 30.6 %

The results of our laboratory testing are included in Appendix D.

5.0 SUBSURFACE CONDITIONS

The Geotechnical Boring Logs and Fence Diagrams in Appendix B represent our interpretation of the subsurface conditions based on tests and observations performed during the drilling operations at the test boring locations and visual examination of the soil samples. The lines designating the interfaces between various strata on the Geotechnical Boring Logs represent the approximate strata boundary; however, the transition between strata may be more gradual than shown, especially where indicated by a broken line. Subsurface conditions may vary between our boring locations.

5.1 Description of General Soil Profile:

The following paragraphs provide a general description of the soil conditions encountered. For soil descriptions at a particular boring location and depth, the respective boring log should be reviewed in Appendix B. Soils encountered on site were typically composed of topsoil, fill / possible fill, alluvial and residual soils. Topsoil is the dark-colored organic soil that develops naturally at the ground surface. Fill soil is composed of materials transported to its current location by man. Alluvial soil has been transported to its present location by water. Residual soils are composed of soil materials developed from the in-place weathering of the underlying bedrock materials. In some cases, it was difficult to distinguish the origins of the soils recovered in the soil borings Therefore, the soil origins depicted in the soil boring logs should be considered approximate.

From the ground surface, all test borings encountered a thin layer of topsoil ranging in depth from 0.3 to 0.6 inches in depth.

Beneath the topsoil layer in borings B-202 to B-204, a dense to very dense layer of graded stone was encountered to depths ranging from 8.4 to 9.0 feet below existing grade. Pieces of Tensar Bx-1100 geo-grid were visible in auger cuttings throughout this interval. It appeared a layer of ASTM #57 stone was present in the lower 1 foot to 2 feet based on auger cuttings. Standard Penetration Test (SPT) results for the basestone ranged from 38 to 78 blows per foot (bpf).

Underlying the topsoil in boring B-201 was basestone from the abandonee roadway followed by a layer of fill. The fill was composed of very stiff, dark red brown sandy clay. The SPT result for this layer was 16 bpf.

Soft to hard Alluvium was encountered in all borings beneath the graded stone and fill soils to refusal. The alluvium was composed of dark brown, light brown and gray brown moist silty clay with black oxide stains and small rock fragments. SPT results for the alluvium ranged from 3 to greater than 100 bpf, but were typically in the soft to firm range. Sampler refusal on rock fragments and the underlying bedrock may have elevated the blow counts

Auger refusal was encountered in all borings at depths ranging from 10.5 feet to 18.7 feet.

5.2 Groundwater Observations:

Groundwater was observed in the borings B-202, B-203 and B-204 at the time of drilling of 14.0, 14.0 and 9.0 feet respectively during augering. Groundwater measurements were also taken at the time of completion and after 24 hours in all borings. Water levels were detected in borings B-202 and B-203 at depths of 17.7 and 16.3 feet at the time of completion. Water levels were recorded after 24 hours in borings B-202, B-203 and B-204 at depths ranging from 7.0 feet to 9.0 feet below the ground surface. Boring B201 was dry. It is important to note that fluctuations in the elevations of the static groundwater table may occur seasonally and are also influenced by variations in precipitation, evaporation, site grading activities, surface water run off and/or the nearby presence of surface water features. The actual depth to groundwater at the time of site grading may be higher or lower than that encountered at the time of the subsurface exploration.

Shield anticipates groundwater will be an issue during construction based on 24-hour water level readings and the method of construction used to stabilize the site previously. Temporary construction dewatering can likely be accomplished by establishing a sump(s) in the excavation and pumping groundwater from the sump. However, depending upon the type of foundation system selected, depth of excavation and the exposed material (e.g. soil versus rock), alternate methods of dewatering may be required.

6.0 LIMITATIONS

~~This report has been prepared for the exclusive use of BWSC for the subject site in Oak Ridge, Tennessee.~~ The information and recommendations reported herein are presented to assist in the evaluation of the site for development. In the event there are any significant changes in the size, design, or location of the project, changes in the planned construction from the concepts previously outlined, or changes of the design parameters stated in this report, the Shield geotechnical engineer should be consulted. The conclusions and recommendations contained in this report should not be considered valid unless all changes have been reviewed and our conclusions and recommendations reaffirmed or appropriately modified, in writing. If we are not accorded the privilege of making this recommended review, we can assume no responsibility for misinterpretation of our recommendations.

If you have any questions regarding the contents of this report, please do not hesitate to contact the undersigned.

Sincerely,

SHIELD ENGINEERING, INC.

C Raum

CLYDE R. TANT, III
REGISTERED ENGINEER
AGRICULTURE
COMMERCE
No. 00105769
STATE OF TENNESSEE
3/23/09

C. Raymond Tant, P.E.
Principal Geotechnical Engineer

J. N. Smith

Jimmy N. Smith with permission CRT

Principal

APPENDIX A

Figure 1 – Site Location Plan
Figure 2 – Boring Location Plan

N

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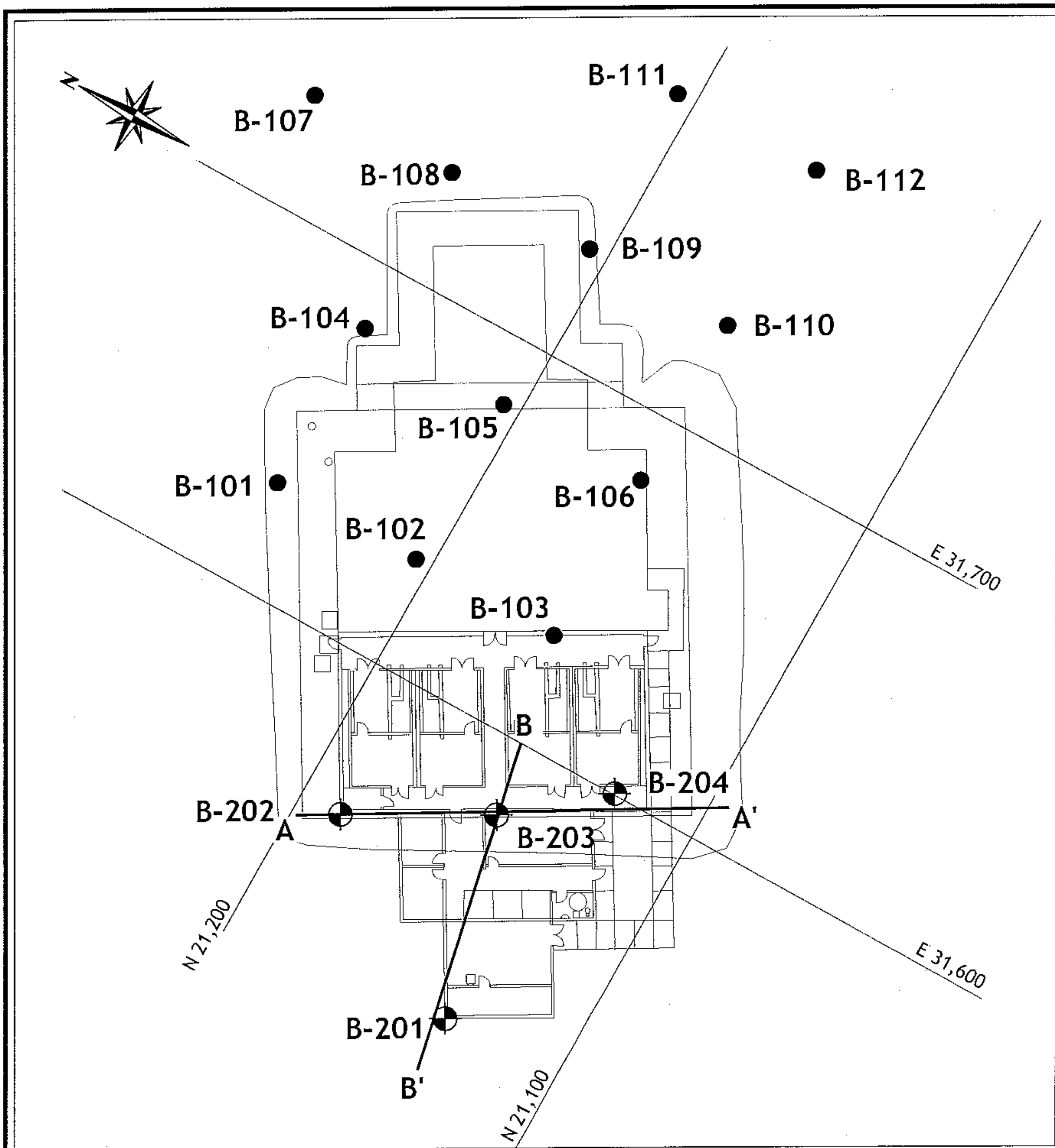
SITE LOCATION PLAN

ADVANCED MATERIALS LABORATORY

OAK RIDGE NATIONAL LABORATORY
OAK RIDGE, TENNESSEE
SHIELD # 1095011-01

DATE :	03/06/09	DRAWN BY :	RBS
SCALE :	N.T.S.	FIGURE :	1

H:\PROJECTS\2009\1095011-01 ADVANCED MATERIALS LABORATORY\FIGURES\SITE LOCATION PLAN.DWG



LEGEND

● B-101	SOIL BORINGS FROM LAWGIBB REPORT 50300-1-1030
B-201	CURRENT SOIL BORING LOCATIONS
A——— A'	CROSS-SECTION LINE

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BORING LOCATION PLAN

ADVANCED MATERIALS LABORATORY
OAK RIDGE NATIONAL LABORATORY
OAK RIDGE, TENNESSEE
SHIELD # 1095011-01

DATE :	03/09/09	DRAWN BY :	RBS
SCALE :	N.T.S.	FIGURE :	2

H:\PROJECTS\2009\1095011-01 ADVANCED MATERIALS LABORATORY\FIGURES\BORING LOCATION PLAN.DWG

APPENDIX B

Key to Soil Classification
Geotechnical Boring Logs
Subsurface Profile

KEY TO SOIL CLASSIFICATION

Correlation of Penetration Resistances with
Relative Density and Consistency

Sands and Gravels

Standard Penetration Resistance	Relative Density
0 - 4	Very Loose
5 - 10	Loose
11 - 30	Medium
31 - 50	Dense
Over 50	Very Dense

Silts and Clays

Standard Penetration Resistance	Consistency
0 - 2	Very Soft
3 - 4	Soft
5 - 8	Firm
9 - 15	Stiff
16 - 30	Very Stiff
31 - 50	Hard
Over 50	Very Hard

Particle Size Identification
(Unified Soil Classification System)

Boulders – exceeds 12 inches diameter
Cobbles – greater than 3 inches to 12 inches diameter
Coarse gravel – greater than ¾ inch to 3 inches diameter
Fine gravel – greater than 4.75 mm to ¾ inch diameter
Coarse sand – greater than 2.0 mm to 4.75 mm diameter
Medium sand – greater than 0.425 mm to 2.0 mm diameter
Fine sand – greater than 0.075 mm to 0.425 mm
Silt and clay – less than or equal to 0.075 mm diameter
(particles cannot be seen with naked eye)

Secondary Modifiers

The second modifiers are generally included when a soil type comprises less than 35 percent of the entire sample.

Percent of Sample	Modifier
0 – 10	Trace
11 - 20	Little
21 - 35	Some

GEOTECHNICAL BORING LOG

Report Date: 02/20/2009
Boring Method: Hollow Stem Auger   Hammer Type: Manual
Logged By: CRT   Driller: TriState
Boring Location:

Boring No.: B-201
Sheet: 1 of: 1
Date Started: 2/20/09
Date Finished: 2/20/09

Surface Elevation: +/- 789.04

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT blows per 6 in.	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
						Topsoil	0.6						
		1		24 / 24 / 20	44	Basestone (From old road bed)	1.0						
						Very stiff dark red brown sandy CLAY - Possible Fill			18				
		2		10 / 9 / 7	16		3.5						
785	5	3		1 / 3 / 5	8	Firm to hard dark brown and grey brown silty CLAY with small rock fragments and sand - Alluvium			23	25	8		
							7.0		15				
		4		25 / 15 / 33	48	Very hard gray limestone							
780	10	5		50/0.3	50/0.3		10.5		4				
						Auger refusal at 10.5 feet							
775	15												
770	20												

GENERAL REMARKS:

GPS DATA:
Datum:
North: 21134.17
East: 31522.39

GROUNDWATER DATA:
During Drilling: Dry Feet
At Completion: Dry Feet
Caved: N/A Feet
After 24 Hours: Dry Feet

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Oak Ridge, Tennessee
Shield Project No.: 1095011-01

GEOTECHNICAL BORING LOG

Report Date: 02/20/2009
Boring Method: Hollow Stem Auger — Hammer Type: Manual
Logged By: CRT — Driller: TriState
Boring Location:

Boring No.: B-202
Sheet: 1 of: 1
Date Started: 2/20/09
Date Finished: 2/20/09

Surface Elevation: +/- 791.48

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT blows per 6 in.	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
		1		13, 19, 25	44	Topsoil	0.5						
790						Dense to very dense graded stone and Geo-Grid - Fill							
	5	2		20, 45, 33	78								
785								▼					
	10	3		3, 3, 4	7	Firm to soft gray-brown moist fat CLAY with sand - Alluvium	9.0						
780		UD		10.5, 12.5	12.5								
	15	4		woh, woh, 3	3	Soft light brown and gray brown silty CLAY with black oxide stains and rock fragments - Alluvium	14.0	▽	18	20	4		
775								▼					
	20					Auger refusal at 18.7 feet	18.6						
770													

GENERAL REMARKS:

GPS DATA:
Datum:
North: 21190.25
East: 31558.86

GROUNDWATER DATA:
▽ During Drilling: 14.0 Feet
▼ At Completion: 17.7 Feet
Caved: N/A Feet
▼ After 24 Hours: 7.0 Feet

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Oak Ridge, Tennessee
Shield Project No.: 1095011-01

GEOTECHNICAL BORING LOG

Report Date: 02/20/2009
Boring Method: Hollow Stem Auger　Hammer Type: Manual
Logged By: CRT　Driller: TriState
Boring Location:

Boring No.: B-203
Sheet: 1 of: 1
Date Started: 2/20/09
Date Finished: 2/20/09

Surface Elevation: +/- 791.45

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT blows per 6 in.	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
		1		6 / 17 / 21	38	Topsoil (0.3)							
790						Dense to very dense graded stone with Geo-grid - Fill							
	5	2		17 / 24 / 27	51								
785													
	10	3		2 / 2 / 3	5	Soft to firm gray brown to brown fat CLAY with rock fragments - Alluvium (Last sample was sandy) (9.0)			23	44	24		
780													
	15	4		woh / 2 / 2	4				31				
775													
						Auger refusal at 17.3 feet (17.3)							
	20												
770													

GENERAL REMARKS:

GPS DATA:
Datum:
North: 21150.8
East: 31579.14

GROUNDWATER DATA:
During Drilling: 14.0 Feet
At Completion: 16.3 Feet
Caved: N/A Feet
After 24 Hours: 7.05 Feet

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Oak Ridge, Tennessee
Shield Project No.: 1095011-01

GEOTECHNICAL BORING LOG

Report Date: 02/20/2009
Boring Method: Hollow Stem Auger   Hammer Type: Manual
Logged By: CRT   Driller: TriState
Boring Location:

Boring No.: B-204
Sheet: 1 of: 1
Date Started: 2/20/09
Date Finished: 2/20/09

Surface Elevation: +/- 792.27

Elevation (feet)	Depth (feet)	Sample No.	Recovery (inches)	SPT blows per 6 in	SPT blows per foot	DESCRIPTION OF MATERIALS (Classification)	Stratum	Groundwater	MC (%)	LL	PI	FINES (%)	COMMENTS:
						Topsoil	0.4						
		1		43 / 26 / 41	67	Very dense graded stone with Geo-Grid - Fill							
790													
	5	2		30 / 27 / 30	57								
785							8.4						
						Stiff light brown and gray brown fat CLAY with rock fragments - Alluvium		▼	27	54	28		
	10	3		11 / 6 / 9	15								
						Auger Refusal at 11.6 feet	11.5						
780													
	15												
775													
	20												
770													

GENERAL REMARKS:

GPS DATA:
Datum:
North: 21125.47
East: 31559.15

GROUNDWATER DATA:
▽ During Drilling: 9.0 Feet
▼ At Completion: N/A Feet
Caved: N/A Feet
▼ After 24 Hours: 9.0 Feet

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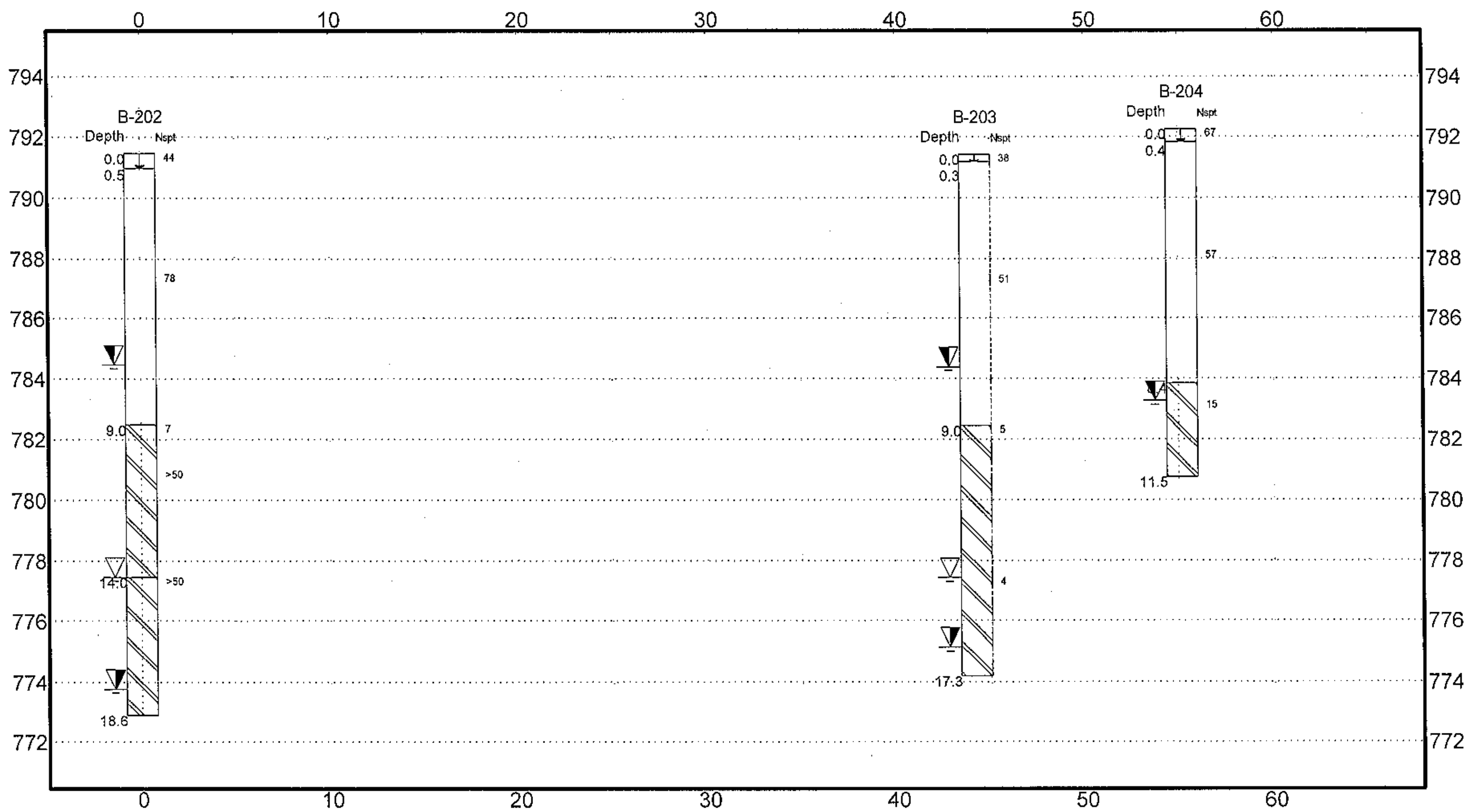
Oak Ridge, Tennessee
Shield Project No.: 1095011-01



Boring	North	East	Elev.	Depth
B-202	21190	31559	791.5	18.7
B-203	21151	31579	791.5	17.3
B-204	21125	31559	792.3	11.6

WATER TABLE
During Drilling - ▽
Completion of Drilling - ▼
24 Hours - ▼

Position	North	East
Left, Front	21190	31559
Right, Front	21135	31593
Left, Back	21190	31559
Right, Back	21135	31593

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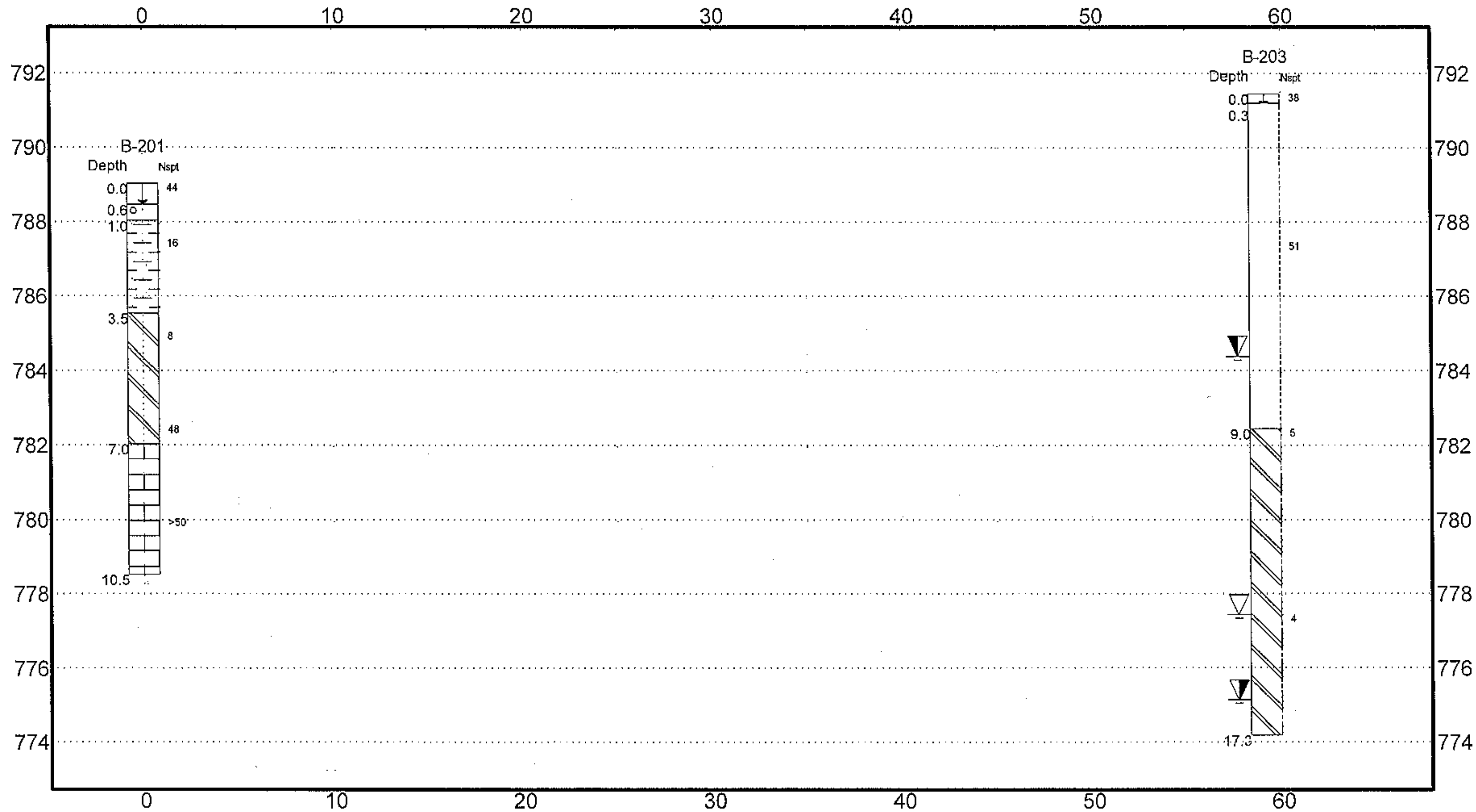
SUBSURFACE PROFILE
Subsurface Profile A-A'
ORNL AML
Oak Ridge

REPORT NO.	DATE	PLATE
1095011-01	02/20/2009	



Boring	North	East	Elev.	Depth
B-201	21134	31522	789.0	10.5
B-203	21151	31579	791.5	17.3

WATER TABLE
During Drilling - ▽
Completion of Drilling - ▼
24 Hours - ▼

Position	North	East
Left, Front	21134	31522
Right, Front	21152	31585
Left, Back	21134	31522
Right, Back	21152	31585

SHIELD ENGINEERING, INC.

SUBSURFACE PROFILE
Subsurface Profile B-B'
ORNL AML
Oak Ridge

REPORT NO.	DATE	PLATE
1095011-01	02/20/2009	

APPENDIX C

Well Plugging and Abandonment Forms

Well Plugging and Abandonment Field Operations Planning Form

1. Well/Boring No : BH-201 Date Installed: 2/21/09
2. Coordinates: Northing 21134.17 Easting 31522.39 Location: N/A
3. Total Depth (ft): 10.5 Feet Inside Dia (in): Soil - 5.25 Rock - 2.96 Casing Length (ft): N/A
4. Screen Length (ft) N/A Ground Elev. (ft): 789.04 Casing Material: N/A
5. Reason for abandonment: Required by UT-Battelle, LLC and State of TN
6. Required site preparation (removal of posts, pads, pumps, etc.): ——
7. Plugging specification document no.: —— Section No : ——
8. Health and safety considerations for well abandonment crew: None
9. Facility Manager: —— Phone No : ——
10. Proposed technical oversight: ——
11. Approved by: ER Program PM: —— Date: ——
12. Approved by GWPC: —— Date: ——

Field Operations Planning Form

1. Well abandonment: Date started: 2/21/2009 Date completed: 2/21/2009
2. Observation via downhole camera: N/A
3. Actual method used to abandon this borehole/well: Backfilled full depth w/- bentonite
4. Actual depth grouted (ft): ____ Was casing split, perforated, drilled etc.? If so, please provide dimensions and locations: N/A
5. Problems and/or deviations from specifications: N/A
6. Date site cleanup completed: 2/21/09
7. Comments: Total grout volume (cf): 1.58
8. P&A report prepared by: Ray Tant -Shield Engineering, Inc. Date: 2/21/09

Well Plugging and Abandonment Field Operations Planning Form

1. Well/Boring No: BH-202 Date Installed: 2/21/09
2. Coordinates: Northing 21190.25 Easting 31558.86 Location: N/A
3. Total Depth (ft): 18.7 Feet Inside Dia. (in): Soil - 5.25 Rock - 2.96 Casing Length (ft): N/A
4. Screen Length (ft) N/A Ground Elev. (ft): 791.48 Casing Material: N/A
5. Reason for abandonment: Required by UT-Battelle, LLC and State of TN
6. Required site preparation (removal of posts, pads, pumps, etc.): ———
7. Plugging specification document no.: ——— Section No: ———
8. Health and safety considerations for well abandonment crew: none
9. Facility Manager: ——— Phone No.: ———
10. Proposed technical oversight: ———
11. Approved by: ER Program PM: ——— Date: ———
12. Approved by GWPC: ——— Date: ———

Field Operations Planning Form

1. Well abandonment: Date started: 2/21/2009 Date completed: 2/21/2009
2. Observation via downhole camera: N/A
3. Actual method used to abandon this borehole/well: Backfilled full depth w/ bentonite
4. Actual depth grouted (ft): ____ Was casing split, perforated, drilled etc.? If so, please provide dimensions and locations: N/A
5. Problems and/or deviations from specifications: N/A
6. Date site cleanup completed: 2/21/09
7. Comments: Total grout volume (cf): 2.81
8. P&A report prepared by: Ray Tant -Shield Engineering, Inc Date: 2/21/09

Well Plugging and Abandonment Field Operations Planning Form

1. Well/Boring No.: BH-203 Date Installed: 2/21/09
2. Coordinates: Northing 21150.8 Easting 31579.14 Location: N/A
3. Total Depth (ft): 17.3 Feet Inside Dia. (in): Soil - 5.25 Rock - 2.96 Casing Length (ft): N/A
4. Screen Length (ft) N/A Ground Elev (ft): 791.45 Casing Material: N/A
5. Reason for abandonment: Required by UT-Battelle, LLC and State of TN
6. Required site preparation (removal of posts, pads, pumps, etc.): ———
7. Plugging specification document no.: ——— Section No.: ———
8. Health and safety considerations for well abandonment crew: none
9. Facility Manager: ——— Phone No.: ———
10. Proposed technical oversight: ———
11. Approved by: ER Program PM: ——— Date: ———
12. Approved by GWPC: ——— Date: ———

Field Operations Planning Form

1. Well abandonment: Date started: 2/21/2009 Date completed: 2/21/2009
2. Observation via downhole camera: N/A
3. Actual method used to abandon this borehole/well: Backfilled full depth w/ bentonite
4. Actual depth grouted (ft): ______ Was casing split, perforated, drilled etc.? If so, please provide dimensions and locations: N/A
5. Problems and/or deviations from specifications: N/A
6. Date site cleanup completed: 2/21/09
7. Comments: Total grout volume (cf): 2.60
8. P&A report prepared by: Ray Tant -Shield Engineering, Inc. Date: 2/21/09

Well Plugging and Abandonment Field Operations Planning Form

1 Well/Boring No : BH-204 Date Installed: 2/21/09

2 Coordinates: Northing 21125.47 Easting 31599.15 Location: N/A

3 Total Depth (ft): 11.6 Feet Inside Dia (in): Soil - 5.25 Rock - 2.96 Casing Length (ft): N/A

4 Screen Length (ft) N/A Ground Elev. (ft): 792.27 Casing Material: N/A

5 Reason for abandonment: Required by UT-Battelle, LLC and State of TN

6 Required site preparation (removal of posts, pads, pumps, etc.): ———

7 Plugging specification document no.: ——— Section No.: ———

8 Health and safety considerations for well abandonment crew: none

9 Facility Manager: ——— Phone No.: ———

10 Proposed technical oversight: ———

11 Approved by: ER Program PM: ——— Date: ———

12 Approved by GWPC: ——— Date: ———

Field Operations Planning Form

1 Well abandonment: Date started: 2/21/2009 Date completed: 2/21/2009

2 Observation via downhole camera: N/A

3 Actual method used to abandon this borehole/well: Backfilled full depth w/ bentonite

4 Actual depth grouted (ft): _______ Was casing split, perforated, drilled etc ? If so, please provide dimensions and locations: N/A

5 Problems and/or deviations from specifications: N/A

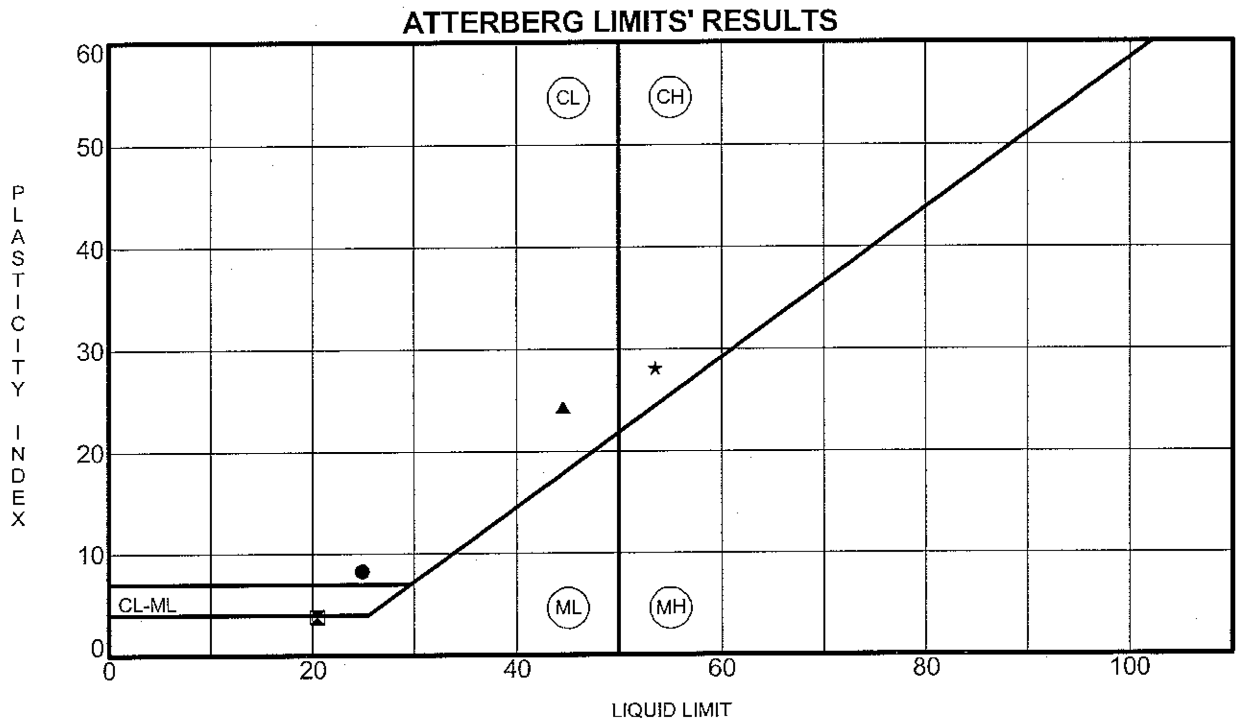
6 Date site cleanup completed: 2/21/09

7 Comments: Total grout volume (cf): 1.74

8 P&A report prepared by: Ray Tant -Shield Engineering, Inc Date: 2/21/09

APPENDIX D

Laboratory Test Results



	Specimen Identification		LL	PL	PI	Fines	Classification
●	**B-201**	4.0-5.5	**25**	**17**	**8**		Lean Clay (CL)
⧗	**B-202**	14.0-15.5	**20**	**17**	**3**		Silt (ML)
▲	**B-203**	9.0-10.5	**44**	**20**	**24**		Lean Clay (CL)
★	**B-204**	9.0-10.5	**54**	**25**	**29**		Fat Clay (CH)

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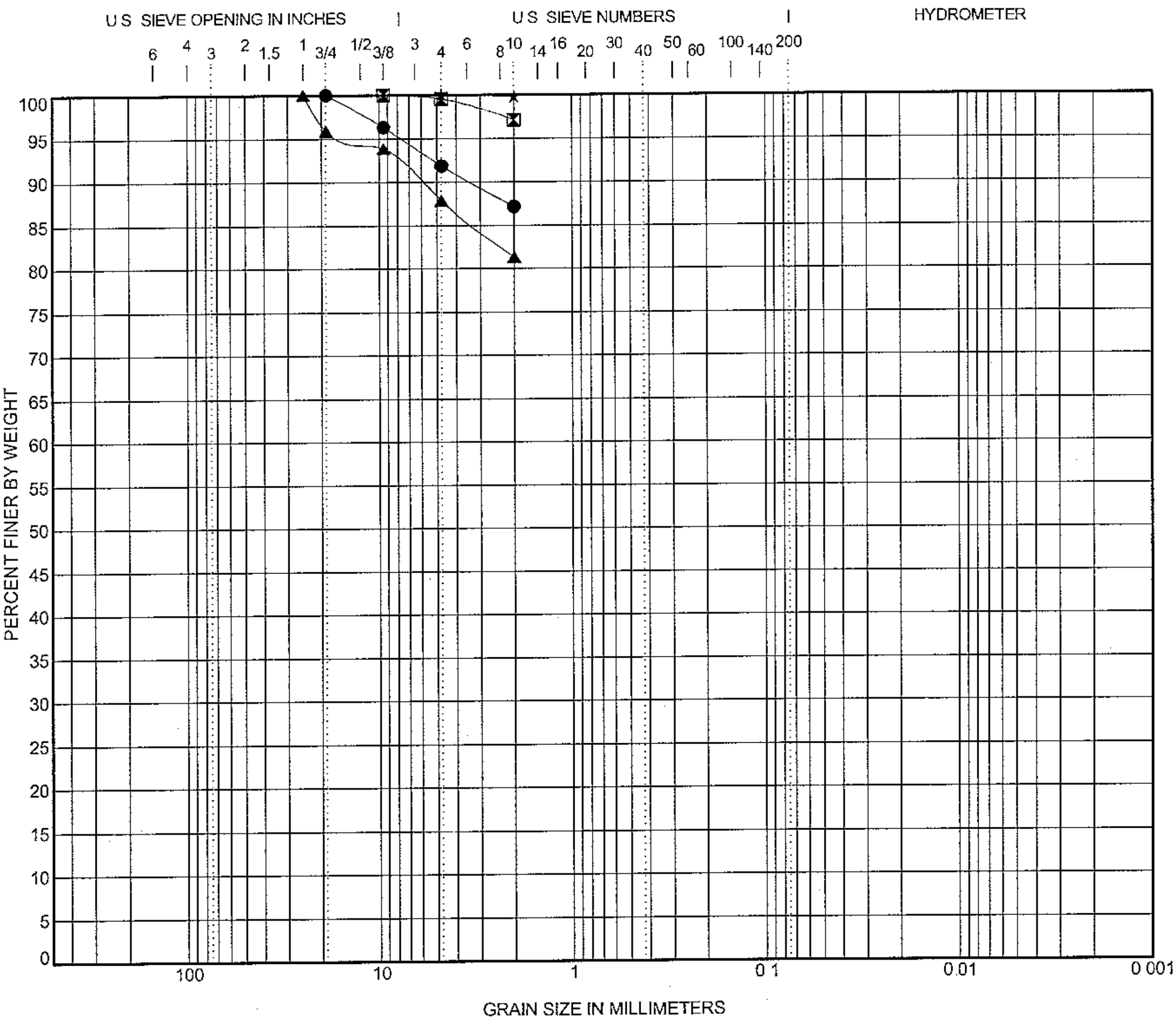
ORNL AML
(Barge Waggoner Sumner and Cannon)
Oak Ridge, Tennessee
Shield Project No : 1095011-01



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-201	4.0-5.5	Lean Clay (CL)					
⊠	B-202	14.0-15.5	Silt (ML)					
▲	B-203	9.0-10.5	Lean Clay (CL)					
★	B-204	9.0-10.5	Fat Clay (CH)					

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-201	4.0	19				8.2			
⊠	B-202	14.0	9.5				0.5			
▲	B-203	9.0	25				12.2			
★	B-204	9.0	4.75				0.0			

SHIELD ENGINEERING, INC.
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GRAIN SIZE DISTRIBUTION

ORNL AML
Oak Ridge, Tennessee
Shield Project No.: 1095011-01

Report of Geotechnical Exploration
ORNL AML Additions
Oak Ridge, Tennessee
Shield Project No. 1095011-01

Laboratory Test Results						
			Natural Moisture Content	Atterberg Limits		USCS Classification
Boring	Sample	Depth (feet)	(%)	Liquid Limit (%)	Plasticity Index (%)	
B-201	S-2	1.5-3	17.9			
B-201	S-3	4-5.5	23.2	25	8	Lean Clay (CL)
B-201	S-4	6.5-8	14.7			
B-201	S-5	9-10.5	3.7			
B-202	S-4	14-15.5	18.2	20	3	Silt (ML)
B-203	S-3	9-10.5	23.3	44	24	Lean Clay (CL)
B-203	S-4	14-15.5	30.6			
B-204	S-3	9-10.5	27.3	54	29	Fat Clay (CH)

OAK RIDGE NATIONAL LABORATORY

OAK RIDGE, TENNESSEE A/E Design and Construction Support Services

Executive Summary

Building 3625- Advanced Microscopy Laboratory Expansion

1.0 Executive Summary

The Advanced Microscopy Laboratory (AML) Expansion project will provide a design for an approximately 3,600 gross square foot expansion to the 3625 Building located in the 3000 Area of the ORNL. The expansion modifications will extend much of the same construction techniques used in the previous to phases to create an environmentally stable area as reasonably possible for the next generation of Aberration Corrected Electron Microscopes.

The instrument section of the expansion will require state of the art environmental stability to reduce the negative effects of:

- Acoustic and Mechanical Vibration
- Electrical Power Disturbances
- Magnetic Fields
- HVAC Temperature Variations and Air Motion

The siting of the (AML) expansion will occur on the south-east side of the 3625 Building as an architectural extension to the previous two phases, with access occurring through a modified existing south side Air Lock Vestibule door coming out of the Phase 1 Chase Corridor as well as a new access point to the Entry Vestibule through the south end of the existing north-east corridor.

The purpose for the (AML) expansion is to provide additional areas for two new Electron Beam Microscopes in a facility that will provide an acoustic and vibration stable environment suitable to not compromise the operational capabilities of these extremely high-performance microscopes. The characteristics of these lab equipment areas needs to be sensitively handled to mitigate environmental influences such as fluctuating magnetic fields, floor vibrations, micro-phonics, electrical ground loops, airflow pressure and rate as well as temperature variations.

The primary purpose of the AML Phase 3 expansion will be to design a microscopy lab facility with state-of-the-art environmental stability control needed for the high-performance resolution levels of this type of equipment described.

As part of the facility design, the Mechanical / Electrical Room houses equipment that produces vibrations and significant magnetic fields, will need to be isolated by means of proper separation clearances are maintained from the AML high volume area where sensitive work will be done.

2.0 Project Background and Justification

The current AML was initially designed by Barge Waggoner Sumner & Cannon Inc as a two phased project. The first phase took place in 2003 as a 6,883 square foot (SF) laboratory starting with four Instrument Rooms adjacent to four Control Rooms. The grouped areas of Control/Instrument Room pairs utilized a surrounding buffer of

Service Chase air space and corridors with slab isolation to control mechanical and acoustic vibrations effects upon sensitive microscope research activities. The Control and Instrument Rooms would be constructed to provide electro-magnetic isolation from surrounding areas. Also included in the facility was a single supporting Prep Lab, Office, Toilet, Storage, Mechanical/Electrical areas. The connecting Service Chase/Corridors were entered into through the Main Entrance which functions as a pressure sensitive Air Lock / Vestibule Display area.

Phase 2 would basically be a mirrored version of Phase 1 in the plan layout so that in the subsequent second phase Service Chase corridors could both function as the means for vibration and electromagnetic buffer for the sensitive Instrument Room areas. The second phase layout took place in 2009 as a 6,345 SF addition. Like Phase 1, it also had four isolated Instrument Rooms with adjacent Control Rooms bordered by a set of buffering Service Control Chases / Corridors. In Phase 2 there was provided one Office, one AV/Conference Room, one area for Microscope Staging, one Restroom and Mechanical / Electrical Rooms. Since Phase 2 was an addition, the Main Entry Vestibule / Air Locks in Phase 1 were utilized with only the addition of a small secondary entry point Air Lock to the south-west side.

As an expansion to the previous first two phases, Phase 3 is being proposed to expand the existing AML Building Advanced Microscopy Lab functions by approximately 3,600 $ft.^2$. The new lab areas will be located on the south-east side of the current (AML) facility with access occurring through the existing south Air Lock leading to a new Corridor / Equipment Chase. Because the existing Air Lock to the south is currently outside the south wall of the existing AML, it will need to be repositioned to the in-board side of the south wall in order to not conflict with the new expansion area. Two new isolated Instrument and Server Control Rooms will be accessed from the new Corridor / Equipment Chase area. Also provided in the list of program spaces will include a separate double occupant Control / Prep Room, a Cryo Recovery Area, Storage Area, Entry Air Lock and Mechanical / Electrical Equipment Room.

Unique to the previous two phases, the Phase 3 Control rooms will become Computer Server Equipment Rooms. A separate Control Prep Room will be location for two office cubicles. The Cryo Recovery Area and Storage Area will be located within the extents of the Corridor / Equipment Chase area and function as a natural buffer between the Mechanical Equipment Room from other sensitive lab areas.

3.0 Needs and Capability Gaps

The following key capability gaps were identified to expand the function and efficiency of the current AML facility.

- Lack of ability to fully isolate microscope bay from changes in air pressure that interfere with ongoing research inside the facility.

- Lack of ability to mitigate measured electromagnetic interference from unidentifiable sources.

The AML Expansion needs were further refined by ORNL in 2020 and 2021 through a series of meetings with managers and user groups.

ORNL is in the process of procuring two new electron microscopes for the AML. The proposed AML Expansion will be approximately 3,600 gross square foot expansion adjoining the south side of Building 3625 referencing the existing AML design with modifications to boost the environmental stability as high as reasonably achievable to accommodate the new electron microscopes. Specifications for the environmental stability associated with the instrument rooms per:

- Attachment 1- Bldg. 3625- AML Addition Design-Build Performance Specification
- Attachment 5- 220201-AML-South-SOW-MEPComments
- Attachment 6- FMS - Low EMI Design Guidance

4.0 Site and Existing Conditions

The (AML) 3625 Building site is located on the south side of the 3000 Area as shown in (Figure 2) and also in the enlarged Campus Aerial view in the (Figure 3) Site Aerial showing AML Expansion.

The site grading directly around the building pad is moderately level on the northeast side but begins to increase on the southwest corner. The proposed 3,600 ft.^{2} AML expansion to the south-east will move the building footprint location roughly three quarters out into the existing paved perimeter drive which will require the road to be closed off and have portions removed. The current building set back from the existing driveway curb is about 12'.

The indicated gray site area of the utility site plan layout in (Figure 6) is reflective of an approximately 4,500 ft.^{2} portion of the existing paved driveway that will be required to be removed and replaced with sidewalk and landscaped lawn. Because of sensitive lab research work, it was recommended remove that portion of roadway in order to limit the perimeter movement of traffic behind the AML Building. The proposed extents of driveway removal will need to be addressed in a civil drawing but are proposed to be up to the south-west gate on one side and over to the north-east drainage curb cut on the other.

The site landscaping shall be compatible with the existing landscaping and promote an open campus feel to the overall environment.

5.0 Storm Water System

The building drainage will be combined with the ground surface drainage.

6.0 Utilities

The water supply for the building will come from the existing 6-inch line located east of the proposed building.

Compressed air from the central ORNL network shall be provided for this new expansion.

Natural gas service is not planned for the proposed building.

CONTROL ROOMS

- CURRENTLYHOUSE ELECTRICAL EQUIPMENT FOR INSTRUMENTATION.
- MOST ALSO HOUSE CONTROL WORKSTATIONS.
- CONTROL WORKSTATIONS SHOULD BE LOCATED IN A SEPARATE ROOM TO AVOID INTERFERENCE.
- NEW CONTROL ROOMS SHOULD BE SMALLER.

INSTRUMENT ROOMS

- CURRENTLY HOUSE MICROSCOPES.
- CURRENT INTERIOR CLEARANCE IS LESS THAN 6" AT CEILING.
- NEW INSTRUMENT ROOMS NEED TO BE APPROX. 24" HIGHER INSIDE.
- CURRENTLY ISOLATED ON 18" SLABS.
- MOBILE CRANES USED PERIODICALLY FOR MANIPULATION OF EQUIPMENT.

MAIN ENTRY

- EMPLOYEES TYPICALLY ENTER AND EXIT HERE.
- AIR LOCK DOORS DO NOT FUNCTION PROPERLY.

PREP LAB STAGING AND

- BOTH ROOMS CURRENTLY USED FOR PREP.
- OFFICE ALSO HOUSES CONTROL WORKSTATION.
- MOBILE BAKING OVENS STORED IN CORRIDORS.
- THESE ROOMS APPEAR TO BE USED AS A BUFFER SPACE BETWEEN MECH. AND ELECTRICAL ROOMS AND THE RESEARCH AREAS.

SERVICE AND EQUIPMENT

- CYLINDERS AND TANKS ENTER/EXIT HERE APPROX. EVERY TWO WEEKS.
- AIR LOCK DOORS DO NOT FUNCTION AS NEEDED.

Figure 1. Plan Diagram of Existing AML

Figure 2. Campus Aerial for the new AML Expansion

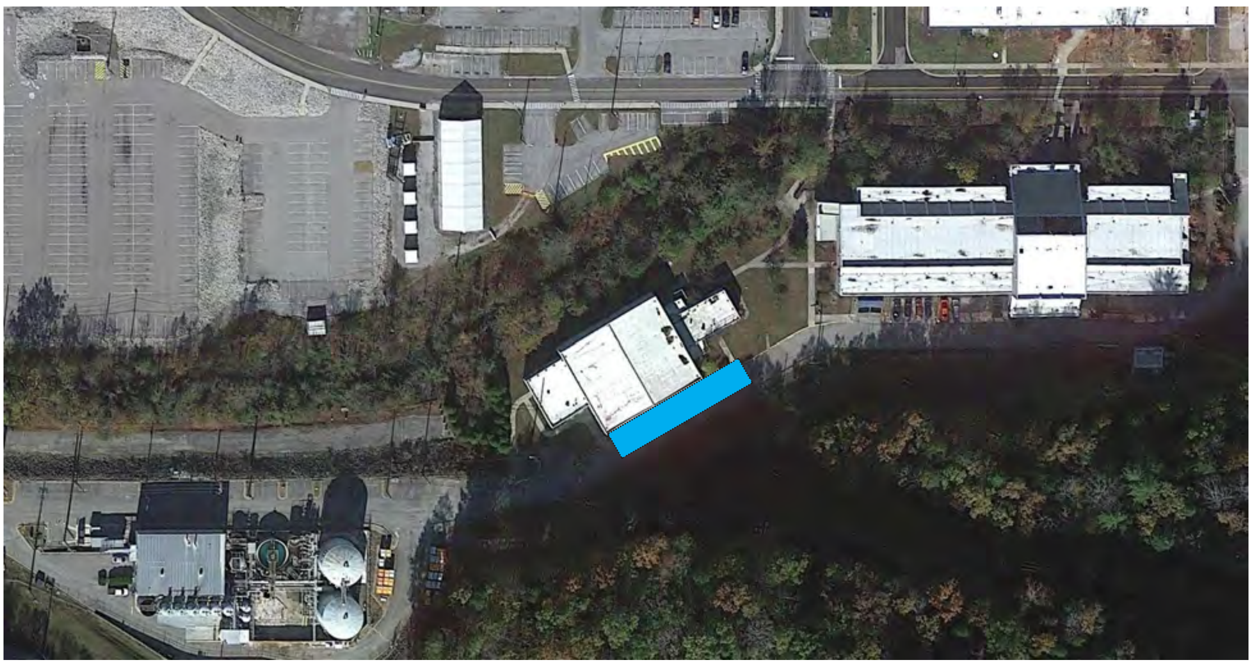

Figure 3. Campus Site for the new AML Expansion

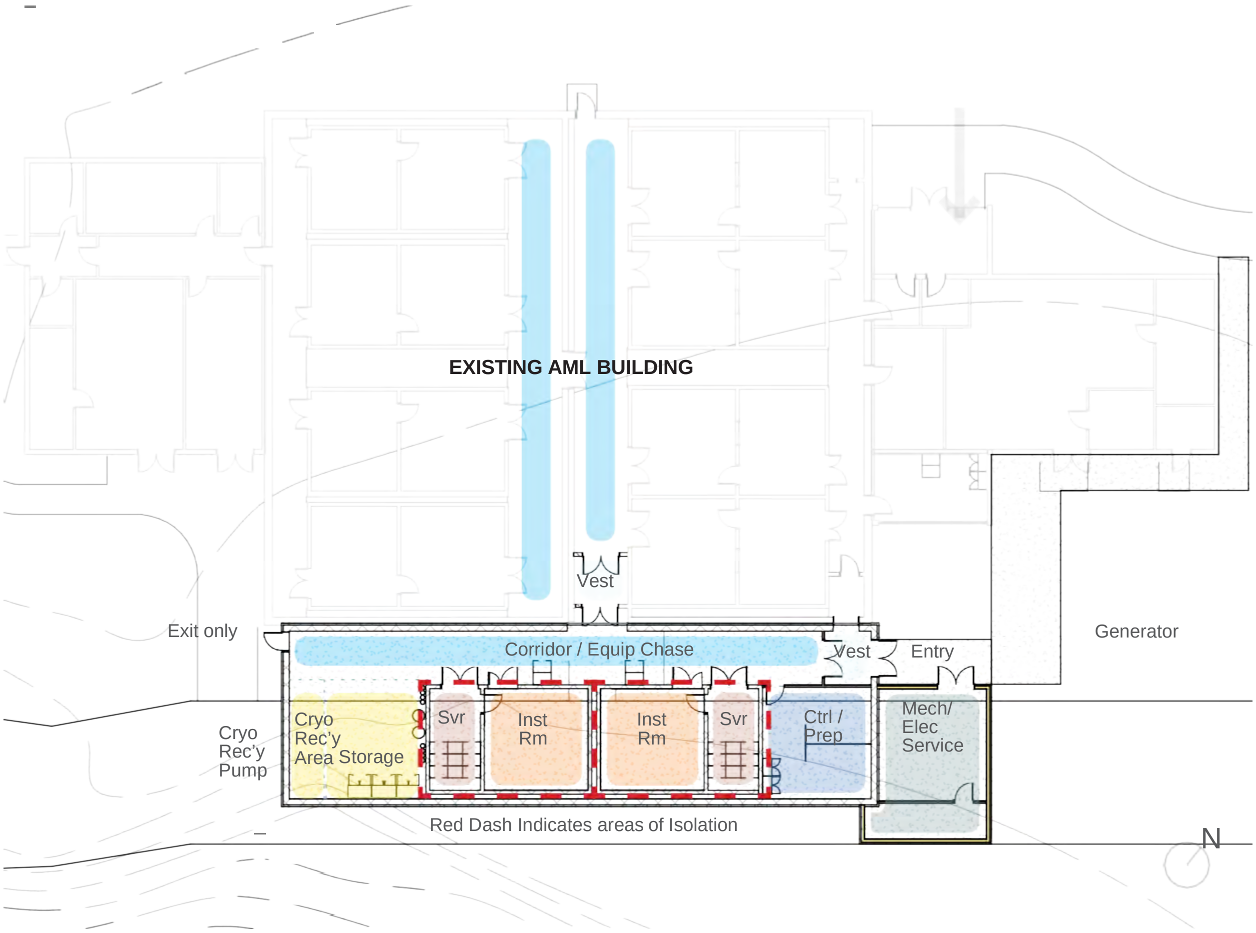

Figure 4. Bubble Diagram

1 MECHANICAL / ELECTRICAL EQUIPMENT
2 AIR LOCK ENTRY
3 CONTROL / PREP ROOM
4 SERVER ROOM
5 INSTRUMENT ROOM
6 CRYO RECOVERY / CORRIDOR EQUIP CHASE

Figure 5. 3D Concept Massing View from Southeast

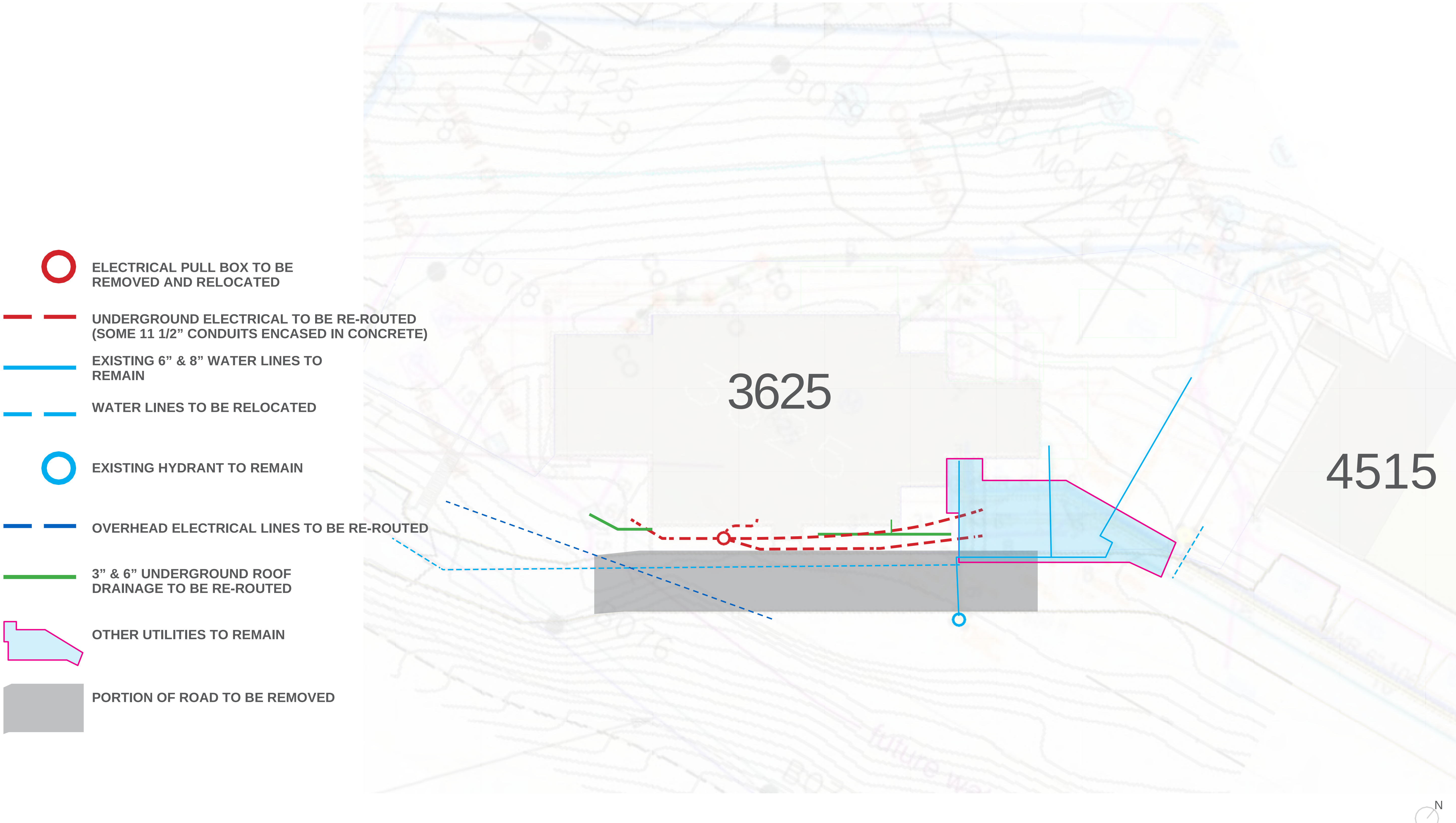

Figure 6. Existing Site Utilities Impacted by the AML Expansion

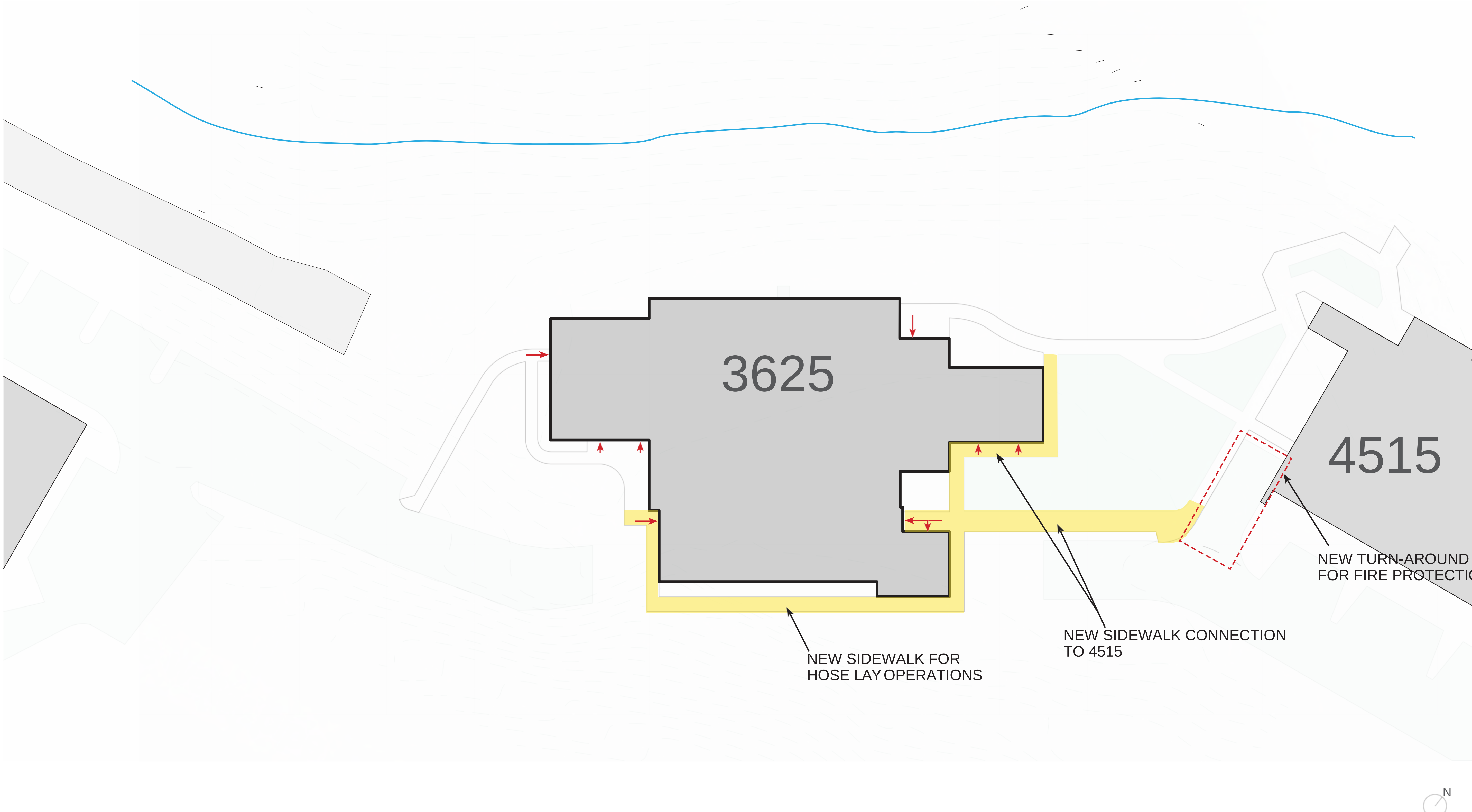

Figure 7. Proposed Paving and Sidewalks

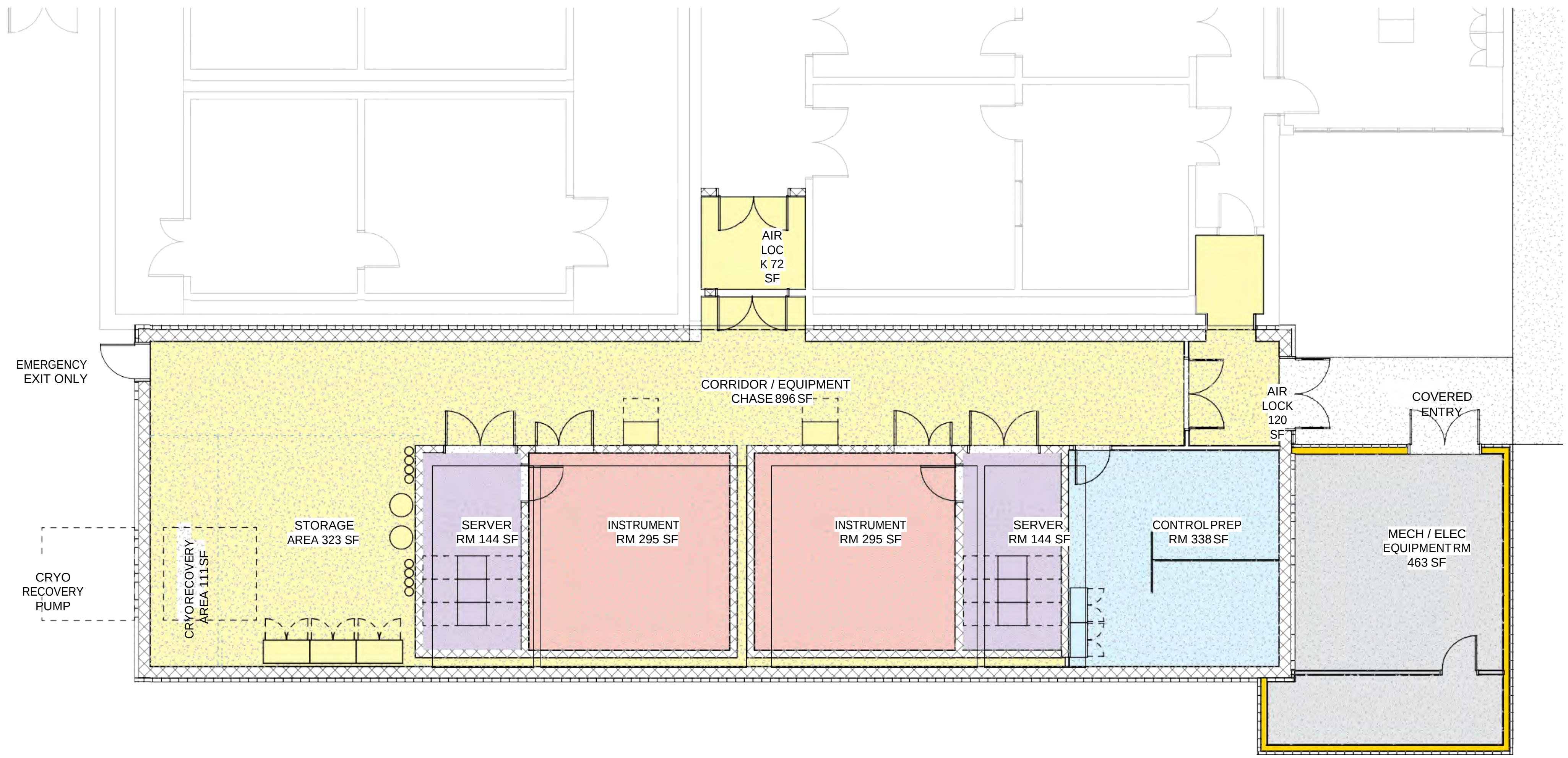

Figure 8. ORNL - Advanced Microscopy Laboratory Expansion - Floor Plan

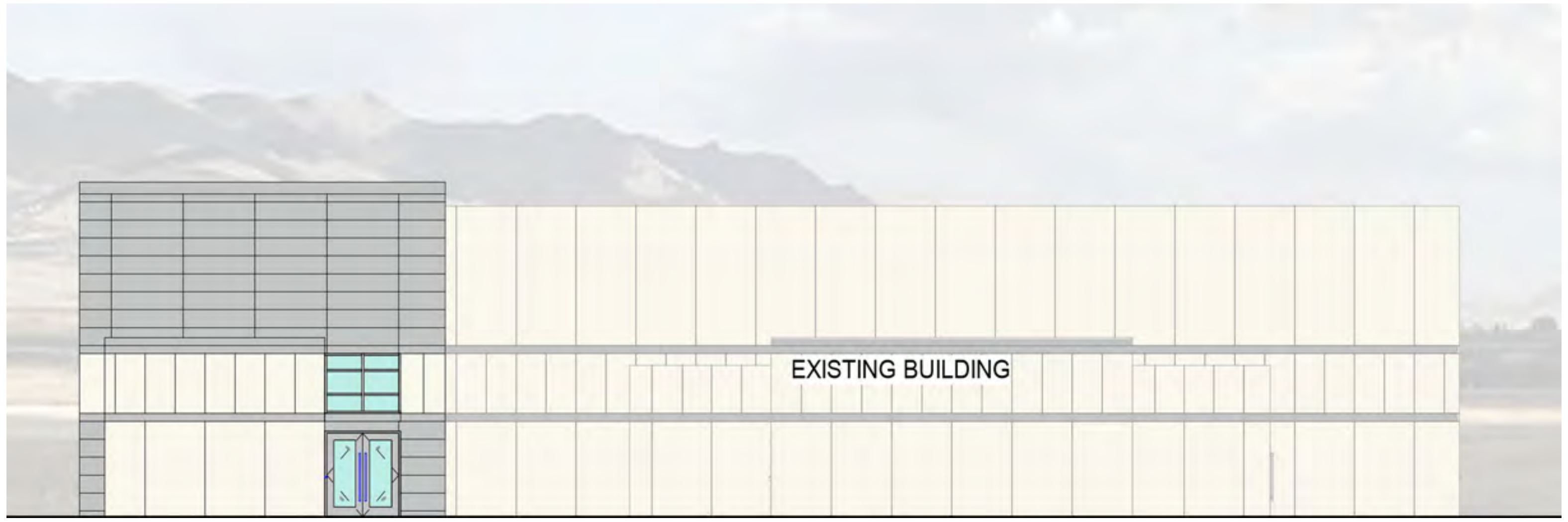

Figure 9. East Elevation

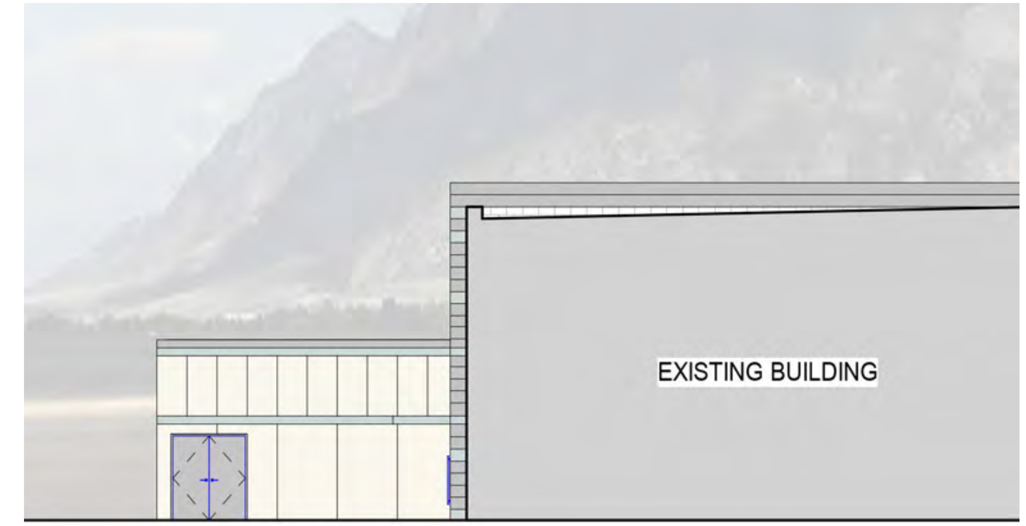

Figure 12. North Elevation

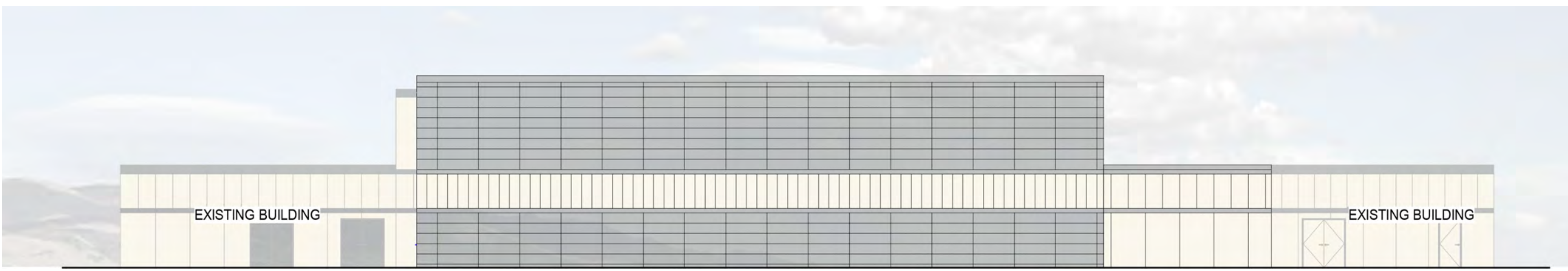

Figure 10. South Elevation

Figure 11. West Elevation

Figure 13. South-East Aerial View of AML

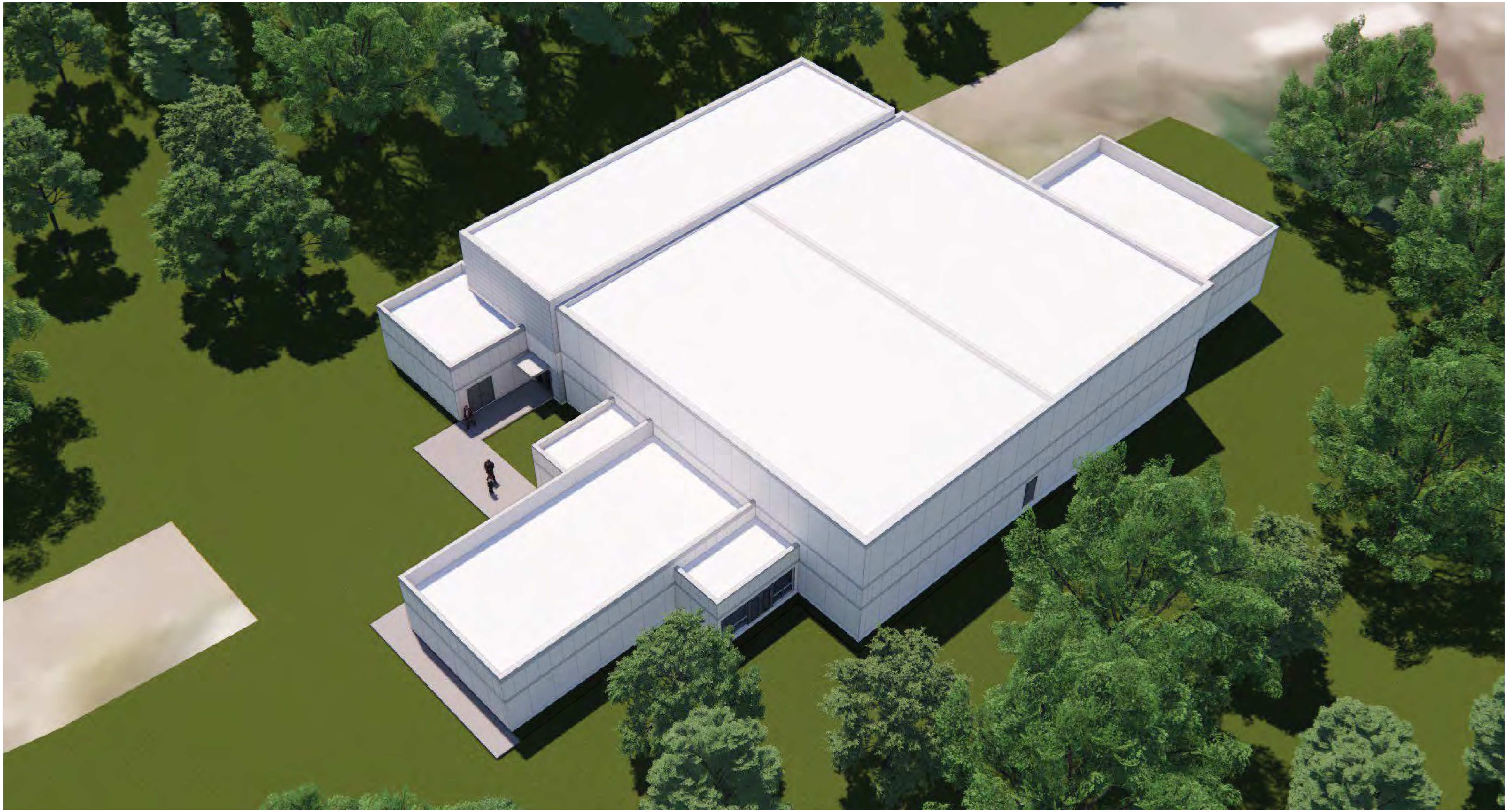

Figure 14. North-East Aerial View of AML

Figure 15. Ground Level View from 4515

Figure 16. Ground Level View from South-East Phase 3 Entrance of AML Expansion

Figure 17. Ground Level View from the South-East

VIBRASURE

Memorandum

To: Jimmy Landmesser, landmessjajr@ornl.gov
From: Byron Davis, byron@vibrasure.com
Date: 1 February 2022
Subject: ORNL / AML South Expansion – M/E/P Isolation Notes

Jimmy: below are our notes regarding mechanical systems vibration isolation for the AML South Expansion. See my other comments in your SOW package for other comments.

General M/E/P isolation notes:

1. Isolate all rotating machinery greater than 1HP using steel spring isolators.
2. Isolate fractional-horsepower machinery as-needed to meet project requirements.
3. Springs shall be laterally stable without housing and have lateral stiffness at least 80% of axial stiffness; diameter not less than 80% of the compressed height; and additional travel-to-solid of at least 50%.
4. The spring element shall be seated in a neoprene cup or incorporate a double-neoprene.
5. Use single-spring isolators. Parallel and nested springs are not allowed.
6. Size springs to achieve 99% or greater isolation efficiency at actual machine RPM, including VFD range.
7. Do not specify any spring system with less than 1” minimum actual static deflection in operation.
8. Seismic controls shall be achieved by snubbers or cabling as appropriate, separate from spring systems.
9. Size machine bases to also support heavy piping, suction/discharge elbows, and similar items.
10. Isolate piping and ducting attached to isolated machinery for the first 25 feet of line length.
11. Utilize spring hangers with 1” static deflection and minimum of 30-degree arc swing in the hanger rod.
12. Isolate floor-mounted transformers with neoprene isolators; do not allow anchor bolts to short isolators.

Please feel free to call or write with any questions or comments; our contact information is below.

Best regards,

Byron Davis, Vibrasure

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LOW EMI DESIGN GUIDANCE

FMS provides the following "Low EMI Design Guidance" for Architects and MEP system design professionals.

These elements are provided for general guidance and implementation into Low EMI projects, laboratories, and facilities. These elements should be implemented in collaboration with your EMI consultant based on the specific needs of a particular project. There are cost-performance tradeoffs that will also apply to specific facilities, instruments, and projects. These elements when properly implemented should ensure an EMI environment that is as low as reasonably achievable for a particular project, external factors notwithstanding. FMS can assist in the proper implementation of the elements of this Low EMI Design Guidance document and can further assist in providing supplemental mitigation measures as necessary.

Electrical Design Considerations

1. Increase (as much as feasible) the distance between electrical equipment and electrical distribution circuits (I.e. primary, secondary, and branches circuits) and any Low EMI instruments or areas.

2. Primary electrical feeders should be encased in steel pipe within 50 feet of any Low EMI areas.

3. Secondary electrical distribution circuits rated for 100 amp equipment connections and higher within 25 linear feet of Low EMI areas should be installed inside rigid steel conduit.

4. Local branch circuiting rated for electrical connections below 100 amps should be installed in EMT conduit at a minimum in Low EMI areas. This includes all branch circuits for lighting and receptacle circuits. For lighting and branch circuits in other areas, consider installing at a minimum – prewired Metal Flex Type wiring. Keep individual wire runs straight and avoid any excess wire or loops in individual branch circuit runs.

5. Use pre-bundled or twisted circuit conductors for individual circuits when possible – see SPLEX product information (https://www.servicewire.com/Products/SPLEX.htm). Or consider the use of zip-ties or other means to bind conductors of the same circuit together – keeping conductors close together to minimize EMI.

6. Circuits not intended to terminate in a specific Low EMI area, or lab, should never pass through (or directly over or under) a Low EMI area.

7. Panels that must be located on common walls of Low EMI areas should incorporate passive AC/ELF shielding.

Lighting Design Considerations:

1. Lighting in Low EMI areas should be LED lighting type, with analog ballast. Utilize resistive/analog dimming, if dimming is required. Avoid Pulse-Width Modulation (PWM) ballasts or PWM dimming when possible.

2. Lighting Fixtures in Low EMI areas shall have a dedicated circuit with a dedicated neutral.

3. Fluorescent lighting should be avoided if possible. If fluorescent lighting is required, use remote ballast type lighting systems and avoid dimmer switches.

Mechanical Design Considerations

1. Increase (as much as feasible) the distance between circuits, feeders, or branches for Mechanical System and any Low EMI areas.

2. Variable Frequency Drives installed in the facility, particularly those in or near Low EMI areas and labs shall include Low EMI provisions. These shall be implemented in coordination with your EMI consultant. Appropriately sized line-side reactors and RF filters should be considered to prevent conducted emissions/harmonics from being introduced on the overall building electrical system. Shielded Cabling should be used on the VFD load side, with load side reactors favorably considered to allow for Low EMI "remoting" of VFD's as required to mitigate "Long Lead Effects".

3. Fan control boxes and dampener controls should be located in corridors adjacent to Low EMI areas, not directly overhead when possible.

4. Flexible fabric or other flexible dielectric supply and return connections at the perimeter of any shielded room should be installed to minimize the potential for circulating ground/stray currents in the Low EMI area.

5. No mechanical piping or ducting shall pass through a Low EMI area unless it is serving the individual Low EMI area.

Plumbing Design Considerations

1. Sprinklers and/or other plumbing should not pass through any Low EMI area to service a different room. All plumbing penetrations should be for the express purpose of serving the sensitive instrument area or lab only.

Any questions regarding these Low EMI Design recommendations may be directed to one of FMS' engineering or technical team members in our NY or Metro DC offices at (212)-628-6860.